

Aristotelian Causation and Neural Correlates of Consciousness

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Abstract: Neural correlates of consciousness (NCC) are neural states or processes correlated with consciousness. The aim of this article is to present a coherent explanatory model of NCC that is informed by Thomas Aquinas's human ontology and Aristotle's metaphysics of causation. After explicating four starting principles regarding causation and mind-body dependence, I propose the Mind-Body Powers model of NCC.

Keywords: neural correlates of consciousness; NCC; consciousness; Aristotelianism; Thomism; human ontology; causation; powers; mental powers

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At the end of the previous century, Francis Crick and Christof Koch (1990) instigated the contemporary search for neural correlates of consciousness. Simply put, neural correlates of consciousness are neural states or processes correlated with consciousness. They are the neurobiological mechanisms that are physically sufficient for a conscious state (cf. Chalmers 2000; Koch et al. 2016, p. 307).

Accurate or not, a common example of a neural correlate of consciousness (for brevity NCC) is C-fiber activation in one's nervous system that takes place when the individual is in a conscious state of pain.¹ According to this example, the NCC of pain is the neural activity in the form of C-fiber activation corresponding to the conscious state of pain. Neural correlates of consciousness yield significant possibilities, such as mapping the brain according to neural activity corresponding to consciousness and more effectively treating the neurobiological basis of various mental illnesses (see brain-map.org).

In this article, I will assume there are NCC (see Koch et al. 2016). My focus is explaining them. It is often thought that NCC provide powerful evidence for physicalism that undermines dualism (see Murphy 1998, p. 13). Elsewhere, I have argued at length that NCC are neutral vis-à-vis physicalism and dualism (see Owen 2019). As Koch has commented:

Note that the NCC themselves are neutral from the point of view of physicalism/materialism or one of the various shades of dualism. Under any reading, consciousness will have physical correlates.²

Given this neutrality, NCC alone cannot justify a particular view of the mind (cf. Chalmers 1998, p. 227; Metzinger 2000, pp. 4-5; Tahko 2012, pp. 40-41).

Nevertheless, it behooves us to consider which views of the mind can adequately account for NCC. In order to make sense of these “discoveries at the mind-brain hinge” we need a logically coherent theory of consciousness (Koch 2012, p. 121). A coherent framework that accounts for the nature of consciousness plus its corresponding neurobiology can help us interpret NCC data. This is where theoretical neuroscience meets the metaphysics of mind, and where the latter can benefit the former.

1 Objective: Metaphysical Model

My aim is to provide a coherent explanatory model of NCC informed by Thomas Aquinas's human ontology and Aristotle's metaphysics of causation. A decade and a half after Crick and Koch (1990) instigated the contemporary search for neural correlates of consciousness, David Oderberg (2005, pp. 90-91) claimed: “for the hylemorphic dualist, such correlations are only to be expected since persons as embodied beings require

¹ C-fiber activation correlated with pain is the standard example in the philosophical literature; therefore I will often use this example. However, as Koch clarified in personal correspondence (8 October 2016) and most other neuroscientists would *not* consider these a true content-specific NCC; just like the optic nerve isn't a visual NCC. Those are input structures that convey action potentials to cortex.”

² Personal correspondence (26 December 2016).

³ ‘Hylomorphism’ is often spelled ‘hylemorphism.’ Regarding the nature of the mind-

corporeal activity in order to interact with the world.”³ If the mind depends on the body to fulfill the functions of a human person, then there will be neural correlates of mental activity, Oderberg reasoned.

More recently, J.P. Moreland (2016, pp. 116-119; 2018) has contributed to this line of thought, arguing that his Thomistic-like dualism entails NCC. Moreland (2016, p. 116) appeals to concepts he believes reflect two versions of “Aristotelian-style dualism.” He appeals to *organicism*, according to which the structures and functions of body parts are determined by the functional demands of the soul that is “the first efficient cause of the body’s development” (2016, p. 119). An alternative to organicism is offered below (see section 5). Moreland (2016, p. 117) also appeals to a notion of mind-body dependence held by the late medieval Aristotelians, as articulated by Dennis des Chene (2000, p. 71):

...by its nature [the human soul] presupposes union with a body, and moreover with a particular kind of body, a body with organs, in order to exercise all its powers – even reason insofar as reason needs the senses to give it material for abstraction.

According to Oderberg (2005, p. 90) and Moreland (2016, p. 117), this idea that the soul relies on the body to exercise its powers suggest that we should expect NCC. But their objectors might allege that their inference is too hasty since the dependence of the mind on the body does not imply patterned processes at the neuronal level. As Moreland (2016, p. 126) acknowledges, more needs to be said. Details must be filled in.

I intend to progress this Aristotelian-Thomistic line of thought and to demonstrate that a view I call ‘neo-Thomistic hylomorphism’ can provide a good explanation of NCC. I will propose an explanatory model of neural correlates called the *Mind-Body Powers model of NCC*. It includes the mind-body dependence referenced by Oderberg and Moreland, but goes beyond Thomistic philosophy of mind and is anchored to fundamental metaphysical principles of Aristotelian causation. My claim is not that neo-Thomistic hylomorphism entails NCC, but rather that it can provide a good explanation (or ‘model/account’) of NCC. The explanation, however, is not a scientific explanation. It is a metaphysical explanation.⁴ It provides a coherent metaphysical framework for understanding NCC that can provide warrant for NCC research and help us coherently interpret NCC discoveries (cf. Koch 2012, p. 121; Moreland 2018, section I.2.1).

According to neo-Thomistic hylomorphism, a human person is a single substance naturally consisting of a substantial form that en-forms matter. The human soul is the

³ ‘Hylomorphism’ is often spelled ‘hylemorphism.’ Regarding the nature of the mind-body dependency alluded to here, see section 3.

⁴ On the value of such explanations, see Tahko (2012, pp. 37, 39, 40-42), Laudan (1977, Ch. 2), and Lowe (1998, p. 9).

substantial form that en-forms matter constituting the body (Aquinas ST 1a 76.1c).⁵ As the form of the body, the soul grounds the body's unity and essence, and thus its existence (ST 1a 76.3c, 76.7c). The soul is united to its body via this grounding relation; that is, the soul is united to its body as its form (ST 1a 76.1c, 76.6c, 76.7c). Therefore, contra Platonism, no accidental or contingent relation such as mover to moved is needed to unite soul and body (see Aquinas QDA 9c; Stump 2003, p. 194). On this view, human nature includes the body, a biological organism unified by a soul that is naturally the form of the body, grounding its unity and essential properties and powers.

The human soul is not a powerless abstract object tantamount to a “free-floating shape” (Pasnau 2012, p. 353). As alluded to above and discussed below (see section 3), the soul is a powerful entity and due to human nature it depends on the body to manifest its powers (see ST 1a 76.5c). Like God and angels, the nature of human persons is rational but it is also sensory, like animals, according to Aquinas (see SCG II.46, 57; ST 1a 89.1c & 75.7 ad 3). Given this, and that he followed Aristotle's thought that the body is required for the soul to sense, Aquinas consider the body necessary for human persons to operate consistently with their nature and therefore essential to human nature (see SCG II.57, ST 1a 84.4c, 89.1c, 75.4c, 75.7 ad 3).

Since the body is an aspect of the soul, according to neo-Thomistic hylomorphism, an embodied soul has physical properties in a derivative sense.⁶ With that said, the most controversial element of the view is that the soul is a substance that is not reducible to the body it en-forms. In this way, the soul is a nonphysical substance even though it has physical properties that are the properties of the body it en-forms. Although this dualist view suggests a controversial interpretation of Aquinas, I will not be defending it in this article on exegetical grounds.⁷ I call the view ‘Thomistic’ assuming that it is appropriate to accredit the foundational ideas to Aquinas, who relied on Aristotle. I call it *neo*-Thomistic since my intention at the end of the day is to defend the most defensible view, which may require modifying Aquinas's original ideas.

I will not be arguing that neo-Thomistic hylomorphism is true, but that *if* it is true, it provides a good explanatory model of NCC. The next four sections explicate the conceptual framework for this model. In Section 2, I rely on Anna Marmodoro's (2014a) reading of Aristotle to introduce fundamental concepts of an Aristotelian powers ontology. Section 3 discusses the dependence of the mind on the body evident in Aquinas's *Treatise on Human Nature*. Applying principles gained from Aristotle and Aquinas, in section 4, I will explicate what I call ‘mind-body powers.’ The conceptual

⁵ When citing Aquinas, I use the following acronyms to reference his works: (ST) *Summa Theologiae*, (SCG) *Summa Contra Gentiles*, and (QDA) *Questions on the Soul*. I also use the acronym (DA) when citing Aristotle's *On the Soul*.

⁶ Cf. Moreland's (2015, p. 201) description of the body as a mode and Lowe's (2009, p. 68) description of non-Cartesian substance dualism.

⁷ On whether Aquinas was a dualist, compare Feser (2009, pp. 162-163), Pasnau (2002b, p. xvii), Freddoso (2012, p. 6, footnote 5), Madden (2013, Ch. 8), and Stump (2003, pp. 212-216). See also Aquinas (ST 1a 75.2sc) and Pasnau's (2002a, p. 225) commentary.

framework is finalized in section 5, which discusses the grounding for biological regularities such as NCC. Section 6 applies the principles discussed in prior sections to propose the Mind-Body Powers model of NCC.

2 Aristotelian Powers Ontology

Aristotle thought objects have powers. According to Aristotelian metaphysics, a power is the capacity to produce change or undergo change (see Marmodoro 2014a, p. 13). In *Metaphysic* (V 12), Aristotle provides a general definition:

Capacity [i.e. power] then is the source, in general, of change or movement in another thing or in the same thing *qua* other, and also the source of a thing's being moved by another thing or by itself *qua* other.

Aristotle here characterizes a power as a source of change. It is important to notice that this source of change includes that which brings about change and also that which undergoes the change (Marmodoro 2014a, p. 12).

The capacity to bring about change is the *active power*, whereas the capacity to undergo change is the *passive power*. Active powers are what they are due to the type of change they can produce and passive powers are what they are due to the type of change they can undergo. A unique feature of Aristotelian powers is that active and passive powers depend on one another for their manifestations; that is, active powers depend on passive powers and passive powers depend on active powers (Marmodoro 2014a, p. 13). "Aristotle defines an active power as one that exercises its powerfulness on a corresponding passive one" (Marmodoro 2014a, p. 13). To use Aristotle's example of a teacher and a learner, the manifestation of the teacher's active power to teach depends on the learner's passive power to learn. If the learner does not manifest the passive power to learn, the teacher's active power to teach will not be manifested.

Furthermore, the teacher's active power to teach is manifested or actualized in the learner, who is taught by the teacher. Aristotle explains in *Physics* (III 3):

It is not absurd that the actualization of one thing should be in another. Teaching is the activity of a person who can teach, yet the operation is performed in something—it is not cut adrift from a subject, but is of one thing in another. There is nothing to prevent two things having one and the same actualization (not the same in being, but related as the potential is to the actual).

The manifestation of the active power to teach is realized in the manifestation of the passive power to learn, and in this way the manifestation of the active power ontologically depends on the passive power (see Marmodoro 2014b, pp. 243-244).

While the example of the teacher and learner conveys the fundamentals, it is easy to imagine examples with more causal complexity. Consider, for example, a hot stove plate heating a metal pot that is heating water with a temperature of 1°C. The stove plate

manifests its active power to heat the pot, which manifests its passive power to be heated as well as its active power to heat the water. And the water acts on the pot as a cooling agent, manifesting its active power to cool the pot, which is manifesting its passive power to be cooled. And as the water affects the pot's surface temperature, perhaps that cools the hot stove plate, however minimal.

In this example, the stove plate, the pot, and the water are each manifesting active powers and passive powers simultaneously and there is mutual causation taking place. This might seem problematic for Aristotelian causation, but as Marmodoro (2014a, p. 41) points out, "Aristotle acknowledges, for example in *Physics* (202a5-12), that in most causal interactions in nature the change is mutual." And despite added causal complexity, what is still taking place is that things with active powers are producing change and things with passive powers are being changed.

To recap, according to Aristotelian metaphysics, powers are real objective features of the world that things have.⁸ Some powers are active; some are passive. An active power is the capacity to produce change in something, whereas a passive power is the capacity to undergo change. The manifestation of active powers depends on the manifestation of passive powers, and vice versa. Certain active powers depend on certain passive powers for their manifestation. In other words, Aristotelian powers "...depend for their activation on the activation of their mutual partner-powers" (Marmodoro 2014a, p. 32). The following tenet offers a succinct summary.

Interdependent Partner-Powers (IPP): Things have active and passive powers. The manifestation of an active power ontologically depends on the manifestation of its corresponding passive power, and vice versa.

In the next section, I will apply this principle to mind-body dependence and introduce mind-body powers.

3 Mind-Body Dependence

According to neo-Thomistichylomorphism, the soul manifests mental powers in conjunction with bodily powers, which are manifested by suitably structured body parts. This idea has exegetical origins in the works of Aquinas. In this section I will briefly

⁸ Powers are irreducible, according to this view. Contra Hume (2007, p. 55), powers on the Aristotelian view are not a mere projection of ours about reality, but rather powers are objective features of reality (Mayr 2016). Entities in the world have powers that cannot be reduced to non-powers. Following Ryle (1949, p. 31), attempts have been made to reduce powers (or dispositions) by giving a conditional analysis of our statements about powers or by reducing powers to non-power properties (cf. Choi and Fara 2016; Mayr 2016). According to the Aristotelian powers ontology I am advocating, such reductivist strategies do not sufficiently describe powers, which seem to be a real feature of the world.

discuss some texts from Aquinas's 'Treatise on Human Nature' found between Questions 75-89 in the first part of the *Summa Theologiae*. However, my focus is not exegetical and therefore the hermeneutical work will be minimal. This section is primarily intended to elucidate the notion of mind-body dependence that informs the concept of mind-body powers foundational to the proposed model of NCC (see section 6).

As one reads Aquinas it is easy to see that he thought powers of the human soul rely on the body. Aquinas (ST 1a 76.8c) makes it clear that powers of the soul are manifested through bodily organs and even located in such organs. Given this, he thought certain powers cease being exercised when the body ceases. According to Aquinas (ST 1a 77.8c), these powers "virtually remain in the soul" but their manifestation depends on the body, "for the action of such capacities occurs only through a corporeal organ." And it is not as though any organ will suffice to carry out any power. Rather certain parts of the body exist to carry out certain powers of the soul, and are thus structured accordingly. The power to see, for example, depends on the eyes, which are structured accordingly and the power to run depends on the legs that are also structured accordingly. As I will discuss below (see section 4.3), this idea that certain powers of the soul are manifested through corporeal structures can also be applied at the cellular level. Granted, Aquinas only applied it to organs, but given that he allowed empirical findings to inform his philosophical positions, he could have developed this principle if he knew what we know from microbiology.

So far so good, when it comes to most powers, those familiar with Aquinas's work might say. However, they might continue, rationality is trickier. Like Aristotle, Aquinas considered rationality to be definitive of humanity.⁹ And he made a case for the immortality of the soul that relies on the power of rationality (see ST 1a 75.2c, 75.3c, & 75.6c). He argued that the human soul is immortal and continues to exist after bodily death and before the resurrection of the body because it has its own operation independent of the body – i.e. rational cognition. In other words, Aquinas thought the soul is immortal because the manifestation of rationality did not require a bodily organ (Pasnau 2002b, p. xvii).

It is easy to misunderstand Aquinas at this point.¹⁰ In light of Aquinas's prevalent acknowledgements of the body's integral role in the manifestation of the soul's powers, one expects to see the same regarding rationality. But in several places Aquinas seems to suggest that the body plays no role in rational thought (e.g. ST 1a 76.1c, ad 1). However, in other places he clearly affirms the role of the body in the exercise of rational thought. For example, Aquinas (ST 1a 84.4c) writes:

But a body seems necessary for the intellectual soul above all for its proper operation, which is to understand. For the soul does not depend on the body for its

⁹ This idea is seen throughout their works regarding human nature. For an example in Aristotle, see *Metaphysics* (I 1); for Aquinas, see (ST 1a 75.4 ad 1).

¹⁰ For in depth exegetical analysis, compare Wippel (2002) and Pegis (1974). My thoughts on the relevant issues have benefited from corresponding with Daniel De Haan.

existence. But if the soul were naturally suited to receive intelligible species solely through an influx from certain separate principles, and if it did not take in species through the senses, then it would not need a body in order to understand and so it would be pointless for it to be united to its body.

This passage makes it hard to deny that Aquinas thinks the body plays a role in understanding.

In another place Aquinas even seems to pinpoint the brain as the organ of thought. After saying that "...capacities do not exist on account of organs, but organs on account of capacities" in Question 78 article 3, in the next article Aquinas (ST 1a 78.4c) says that physicians have assigned a definite organ to "particular reason," that organ being "the middle part of the head." Robert Pasnau (2002a, p. 283) comments that Aquinas followed the contemporary science at the time in holding that the four internal senses are in the brain.¹¹ Given this, it is not surprising that Aquinas thought that damage to the organ relevant to understanding impedes understanding (ST 1a 84.7c).

How can we make sense of Aquinas apparently contradictory affirmations? On the one hand, he seems to claim human rationality is manifested independently of the body, yet on the other hand he seems to claim that the body plays a necessary role in rational thought. One way to summarize Aquinas's view of rational cognition in a coherent way is as follows: rationality is an independent operation of the soul in that it does not necessitate the body in one sense but it does necessitate the body in another sense, which requires further explication.

It is important to remember that according to Aquinas's view the human soul is essentially rational, but not only rational. It is also essentially sensory. As a rational soul that is also sensory, the human soul has a particular natural mode of rational cognition that requires what Aquinas calls *phantasms* (or, sense images) that require the ability to sense and thus a body (cf. Aquinas SCG II.57, QDA 1; Aristotle DA II 5). Nevertheless, while the soul has a natural mode it also has a possible alternative mode, as Aquinas (ST 1a 89.1c; cf. 75.7 ad 3) explains:

Therefore with respect to the mode of existence by which the soul is united to a body, the appropriate mode of understanding for the soul is to turn toward the phantasms of bodies, phantasms which exist within bodily organs. But once it has been separated from its body, the appropriate mode of understanding for the soul is to turn toward intelligible things straightaway—just as is appropriate for other separate substances. So turning toward phantasms is, for the soul, its natural mode of understanding, just as being united to a body is natural. But being separated from its body is foreign to the character of its nature, and understanding without turning toward phantasms is likewise foreign to its nature. So it is united to a body in order to exist and operate in keeping with its nature.

¹¹ The four internal senses are: common sense, imagination (i.e. phantasia), cogitative power, and memory (Pasnau 2002a, p. 281).

The defining capacity of humanity necessitates the body for its natural operation but not for its possible alternative operation (Aquinas QDA 1).

Aquinas's position will strike many moderns as idiosyncratic. But it is important to remember that Aquinas's most developed philosophical reflections on human nature were done in a theological context thought to include divinely revealed knowledge that philosophical knowledge coheres with (see Aquinas ST 1a 1; Pasnau 2002b, p. xiii). Thus Aquinas thought carefully about how his philosophical commitments regarding the soul are consistent with the Christian doctrine of the intermediate state, which teaches that the human soul continues to exist disembodied after bodily death until an eschatological bodily resurrection. Aquinas's discussions of the soul during the intermediate state illuminate the nature of the mind-body dependency evident in his human ontology. During the intermediate state, it is metaphysically possible for the soul to manifest rational thought without the body via a mode of operation that is not natural, though it is metaphysically possible. The idea that the human soul is relegated to such an unnatural operation of a characteristic capacity during the intermediate state fits with the Christian eschatological hope that God will resurrect the body as part of his salvific plan to restore humanity. After all, if the body is essential to human nature as described by Aquinas, a resurrection of the body would seem to be a prerequisite for a fully flourishing eschatological human existence (see Aquinas SCG IV.79).

In sum, the human soul, which is both rational and sensory, requires the body to exercise its powers according to its nature. The body is metaphysically necessary for the human soul to naturally operate, even though it is metaphysically possible for the soul to cognize in an alternative unnatural way apart from the body. There is much more to be said about properly interpreting Aquinas (see Pegis 1974; Wippel 2002). However, what will have to suffice for present purposes is a summary of a concept informed by Aquinas's thought on mind-body dependence that is foundational to the Mind-Body Powers model of NCC.

Mind-Body Powers (MBP): There are mental powers of the soul and physical powers of the body that are interdependent partner-powers. The natural manifestations of active powers (whether mental or physical) ontologically depend on the manifestation of passive powers (whether mental or physical), and vice versa.

According to neo-Thomistic hylomorphism, human persons have mental powers and physical bodily powers that are interdependent partner-powers, which I call 'mind-body powers.' Since these powers are vital to the model of NCC presented in section 6, it will be helpful to explicate them further before applying them to NCC.

4 Mind-Body Powers

One can conceive of bodily powers manifested apart from mental powers (consider a heart pumping blood) and mental powers manifested without bodily powers (consider the

disembodied rational souls discussed above). Whether or not they exist, such powers are not my present concern. Rather, this section is focused on mind-body powers. I am interested in powers of the body and mind that naturally require mutual manifestation.

4.1 Interdependence

To illustrate the concept of mind-body powers let us use an example of a voluntary act of running undertaken by Olympic gold medalist, Allyson Felix. Let us keep things simple and stipulate that the voluntary act of running relies on the mutual manifestation of the following partner-powers. Felix manifests a mental active power: (*M-Power*) choosing to run. As a result, she manifests passive bodily powers: (*B-Power*) neurons fire, muscles contract, and her legs stride one in front of the other. In actuality things are much more complex, especially on the physiological level. (The bodily physiological powers will include countless manifestations of active powers and passive powers as well as powers that are both active and passive.) But our example need not include all the nuances to illustrate the key idea regarding mind-body powers. And that is, both *M-Power* and *B-Power* are needed for this voluntary act of running undertaken by Felix.

The reason neurons start firing and ultimately Felix's legs begin striding forward is because she chose to run, and because she chose to run the manifestation of *B-Power* is part of a voluntary act of running. In this way the manifestation of *B-Power* ontologically depends on the manifestation of *M-Power*, choosing to run. Yet it is also true, according to my account, that *M-Power* could not be manifested without *B-Power*. Granted, Felix could manifest the power to intend to run without the correlated *B-Power*, but intending to run is not the same as choosing to run. One can only choose to do something that she has the choice to do, and she only has the choice to do *x* if she can do *x*. *B-Power* makes it possible for Felix to run and thus possible for her to choose to run. So in this way the power to choose to run – that is, *M-Power* – ontologically depends on *B-Power*.

Aquinas made a similar claim. According to Aquinas (ST 1a 76.4 ad 2), the soul moves the body "...through its potential for producing movement, the actualization of which presupposes a body." The soul has the power to move the body, but this power cannot be manifested without a body. But notice that Aquinas writes that the power to move the body presupposes *a* body, not this particular body or that particular body. A body will do. Getting back to our example, Felix need not have the exact physiological makeup that she in fact has in the actual world in order to have and manifest *M-Power*. She could have had a different physiological makeup with different physical powers that still resulted in legs striding forward as a result of the manifestation of *M-Power*. This is important because it allows for multiple realizability.

Our example involves an active mental power. However, we could have given an example with a passive mental power, such as a pinched nerve being the active power that changes one's felt experience to a state of pain. There can be active mental powers and active bodily powers. Likewise, there can be passive mental powers and passive bodily powers. Regardless of whether an active power is physical or mental, its manifestation ontologically depends on the manifestation of its correlate passive partner-

power. Likewise, mental and physical passive powers depend on correlated active powers. These interdependent mental and physical bodily partner-powers are mind-body powers.

4.2 Ontological Extension

It is tempting to picture in our minds an external relation relating an active power to its correlated passive power. However, as Marmodoro (2014b, p. 244) explains:

...The causal interaction of the active and the passive powers is not reified by Aristotle as a relation, but as an ontological extension of the agent onto the patient. Aristotle does not posit a relation between active and passive powers to explain the mechanism of causation, but treats the active power as ‘extending’ onto the passive one, not through a relation but by ‘spreading itself’ onto the patient – by making the patient’s constitution part of the agent’s own constitution; by having the patient as the ground of realization of the agent’s own causal power.

The manifestation of the passive power is a constituent of the active power’s manifestation. The manifestation of the active power comes to be completely realized in the manifestation of the passive power.

Returning to our example of Allyson Felix’s voluntary act of running, her act of choosing to run is realized in neurons firing, muscles contracting, and legs striding forward. That is, the manifestation of Felix’s *M-Power* is realized in the manifestation of *B-Power*. That does not mean *M-Power* is reducible to *B-Power*. But it does mean that the manifestation of *B-Power* is a constituent of the manifestation of *M-Power*. Since *B-Power*’s manifestation is a constituent of *M-Power*’s manifestation, the manifestation of *M-Power* ontologically depends on the manifestation of *B-Power*. And as I will discuss next, the manifestation of mental powers requiring the co-manifestation of body powers depends on physical properties.

4.3 Requisite Physical Properties

Presumably like many others, I would like to fly like a bird, without the aid of technology such as a plane or a wingsuit. However, this is impossible. The reason is that birds have a different type of body with different body parts capable of manifesting different bodily powers. And certain actions require bodily powers manifested by body parts with sufficient physical properties.

A critical tenet of the hylomorphic view I am advocating is that certain types of mental powers require certain types of bodily powers, and vice versa. Moreover, certain types of bodily powers require certain types of bodily features. So in other words, certain types of mental powers cannot be naturally manifested apart from the manifestation of certain types of bodily powers that require certain types of physical characteristics in the body. The manifestation of Felix’s mental power to choose to run requires the bodily

power to stride forward with one's legs. And this bodily power to stride forward requires a type of physical bodily feature, namely legs. Felix could have various types of legs and still run, but she does need legs of some type.

Aquinas thought that the human soul has a variety of powers and therefore the human body must have a variety of powers so that the soul's various powers could be manifested. In Question 76 article 5 of the first part of the *Summa Theologiae*, Aquinas addresses the question: What type of body should have the human soul as its form? In this context, Aquinas (ST 1a 76.5 ad 3) writes the following about the human soul, or as he calls it, the intellective soul:

For although it [i.e. the intellective soul] is one in essence, nevertheless, due to its perfection, it has *multiple powers*. Hence for its various operations it needs *various dispositions in the parts of the body* to which it is united. This is why we see that perfect animals have a greater *diversity of parts* than do imperfect animals...¹²

Notice that Aquinas moves from the powers of the soul to the powers of the body to the parts of the body. To manifest its various powers the soul needs various bodily powers, which require certain body parts.

If the powers of the soul could be manifested with the co-manifestation of just any body power using just any body part, then any type of body would do and there would be no need for a variety of bodily powers and bodily parts. You could just have the soul manifest its powers through any bodily power in any body part. So if any body part would do, you would only need one part or at most one type of part. But according to Aquinas, the human soul requires a body of a certain type, namely one with a variety of bodily parts with various bodily powers. Such a body is needed because the soul's various powers depend on the co-manifestation of certain bodily powers and not just any bodily power, according to Aquinas. And particular bodily powers require the body to have certain types of physical features. So the body's form, the soul, and its powers determine the characteristics of the body.

The idea that the soul's powers require bodily powers manifested by body parts with sufficient physical properties was applied by Aquinas on the macro level of bodily organs. For example, he wrote: "In our soul there are certain powers whose operations are exercised by means of corporeal organs, and powers of this sort are acts of certain parts of the body, as vision in the eye and hearing in the ear..." (ST 1a 54.5c in Stump 2003, p. 199). However, this same concept can be applied at more micro levels. Due to scientific advancements since Aquinas's time (1225-1274 A.D.), we know much more about the body beyond the level of organs. In the light of modern science, we can apply Aquinas's line of thought about requisite physical properties to micro levels of bodily composition. From macro to micro levels, we can infer, body parts with certain physical properties or

¹² Italics mine.

types of properties are needed in order to manifest certain bodily powers that are interdependent partner-powers of mental powers. The idea can be summarized like so.

Requisite Physical Properties (RPP): From macro to micro levels, body parts must have sufficient types of physical properties in order to naturally manifest the bodily powers that co-constitute mind-body powers.

Requisite physical properties can pertain to anything physical, from structure to complexity, to electrical charge, to chemical composition, etc. The physical properties might be something very specific or simply a type of physical characteristic. Of course, we will want to know what bodily powers and physical properties the body must have and why it must have them in order for corresponding mental powers to be manifested. This is where fields such as neurobiology and neurophysiology can be invaluable.

Before presenting the Mind-Body Powers model of NCC, one last principle of neo-Thomistic hylomorphism must be expounded. This final principle pertains to the form of the human body grounding biological regularities.

5 Biological Regularities

One thing about NCC that invites an explanation is the regularity with which particular neural processes correlate with certain types of mental states throughout a species. The consistency is seen not only in individual brains but also brains across species, making it theoretically possible to map the brain of a species such as the mouse brain or human brain (see brain-map.org). The hylomorphic account of NCC proposed in the next section explains the consistent regularities of NCC across the human species by appealing to the idea that all humans have the same type of form. And that form, according to the account, determines the sameness (or regularity) of biological organization, structures, and processes in the body at the macro and microbiological levels.

As mentioned in section 1, Moreland (2016, pp. 116, 118-119) appeals to organicism in addition to mind-body dependence when arguing for his Thomistic-like dualism. According to Moreland's (2016, p. 119) description of organicism, the structure and function of body parts are determined by the functional demands of the soul that is "the *first efficient cause* of the body's development."¹³ Here, I recommend an alternative. On my view, the form ultimately grounds the regularities of biological organization, structure, and processes across a species; but this does not involve the form as an efficient cause of the body's development. Instead, I concur with John Haldane (1998, pp. 275-276):

I wish to maintain that form may be a determinant of the substantial nature, including the characteristic activities, of a substance without that being a matter of efficiently constraining the location and behavior of basic particles...what form brings is order, but it does not do so by pushing things this way or that. Its

¹³ Italics mine.

existence is testified to not by force detectors but by the fact that what exists, and how existents act, exhibit natural order.

On the view I am advocating, the substantial form determines the standard biological structures and processes across a species – i.e. biological regularities – but the efficient causes of their development are merely biological causes, not the form.¹⁴

The type of biological regularity that concerns us is the sameness in organization, structure, and function of biological parts across a species, from the macro level of organs to sub-cellular microbiological levels. According to neo-Thomistichylomorphism such regularities across a species are ultimately grounded in the fact that the members of the species have the same type of form. Substantial forms ground the essential properties and powers of the organisms they en-form, which determines the developmental possibilities and parameters of the organism (cf. Pruss 2013, p. 131). This guides the patterns of biological development that produce organized structures with standard functions via biological causes, which are the efficient causes of such development. So on one level there is the form that determines the structure and standard function of the organism. On another level there is the biological processes of development that are the efficient causes that produce the structures and standard function of the organism's biological parts.

As Aquinas (ST 1a 76.5c) wrote "...the reason why matter is such as it is must be drawn from the form, not vice versa." One might wonder how this is consistent with neuroplasticity. After all, we know the brain can undergo traumatic injuries affecting its structure and via neuroplasticity adapt to retain or regain mental capacities that typically rely on a damaged region (see Cramer et al. 2011; Goodrich et al. 2013; Munoz-Céspedes et al. 2005). Such a possibility might seem incompatible with the idea that the form of the human body determines that its parts will have particular structures and functions. However, the form of the body also determines developmental possibilities, as alluded to above. So it is important to keep in mind that the form, which grounds the essence of the body, not only grounds what will develop but also what could develop in certain atypical scenarios.

To summarize, according to neo-Thomistichylomorphism biological regularities across a species are grounded in the same type of form across the species and the same is true for the regularity of biological possibilities. Members of a species develop standard macro and microbiological structures with particular functions due to the sameness of form type. Likewise, the regularities of biological possibilities and impossibilities across a species are grounded by the sameness of form type across the species. This final principle can be summarized as follows.

Forming Biological Regularities (FBR): The form of the body grounds biological regularities in the body throughout a species, and specifically macro and

¹⁴ See also Marmodoro and Page (2016, p. 16). They likewise emphasize that a substantial form is not an efficient cause.

microbiological organization, structure, and function of the body's constituent parts.

FBR finishes off the conceptual framework for the proposed model of NCC, to which we now turn.

6 The Mind-Body Powers Model

This section presents the Mind-Body Powers model of NCC, which fundamentally relies on mind-body powers. I will use an example of a bee sting to introduce the model, and then further explicate it in light of David Chalmers's definition of NCC. The model shares commonality with several Aristotelian and Thomistic accounts of human action and neural correlates that appeal to mind-body dependence.¹⁵ To be clear, however, the Mind-Body Powers model of NCC is focused on explaining specifically neural correlates of consciousness, not human action, although it can be applied to action. The model anchors the concept of mind-body dependence to foundational principles of Aristotelian causation.

6.1 Mind-Body Powers & NCC

To illustrate how mind-body powers apply to NCC, let us consider the felt sensation that Freddy feels when a bee stings his foot. Freddy's mental state – the vivid feeling of a bee sting – is irreducibly mental, but it is not without requisite physical causes. When Freddy feels the bee sting his mental power to feel such is manifested because the body exercised certain physiological powers. In fact, the manifestation of his mental power in this case requires the co-manifestation of certain physical powers of the body. It would not genuinely be the feeling of a bee sting if there were not a physical stinger that penetrated Freddy's skin and injected melittin that caused physiological reactions, which in this case include firing synapses sending an electrical signal to a region in his brain. Without a bee stinger and the resulting physiological reactions, perhaps he could have a "phantom" sensation of a bee sting, but it would not genuinely be the felt sensation of a bee sting.

For Freddy to feel a bee sting his mental power to feel such must be manifested. But it also must be the result of physical events in his body as certain physiological powers are manifested. This is where mind-body powers apply. There is a required co-manifestation of the mental power Freddy has to feel a bee sting (MP^{sting}) and the bodily physiological powers (BP^{sting}). This co-manifestation of powers entails a correlation between the manifestation of the mental power and the bodily physiological powers. Thus we could expect correlations between mental events when the mental powers are manifested and physical events when the corresponding bodily powers are manifested (cf. Moreland 2016, p. 117; Oderberg 2005, p. 90). After all, the mental and physical powers

¹⁵ Cf. Haldane (1998, pp. 271-272), Oderberg (2005, p. 90), Lowe (2006, pp. 11-19), Moreland (2016, pp. 116-119; 2018), and Jaworski (2016, p. 281).

are interdependent partner-powers. So the concept of mind-body powers leads us to expect a correlation between the manifestations of mental and physical bodily powers.

However, this correlation between mental and bodily powers does *not* itself imply a correlation between the mental and specific neuronal states or activity. More is needed to arrive at and account for neural correlates of consciousness. Of aid is the concept introduced above regarding bodily powers requiring physical properties – RPP. From macro to micro levels, body parts must have certain physical properties or types of physical properties in order to naturally manifest the bodily powers that co-constitute mind-body powers. In other words, the manifestation of a bodily power that is the interdependent partner-power of a mental power requires a body part(s) with sufficient physical properties. That is the claim of this principle, RPP, which is a natural part (or implication) of Aquinas’s thought. Thus in reference to our example, the manifestation of Freddy’s bodily powers (BP^{sting}), which correlates with his mental power, naturally requires physical bodily parts with certain types of physical properties.

So neo-Thomistic hylomorphism, as I have described it thus far, claims human persons have mind-body powers consisting of interdependent mental powers of the soul and physical powers of the body. And the physical powers of the body require certain physical properties from the macro to the micro level in order to manifest. Due to this and the fact that the brain manifests such bodily powers, certain parts of the brain down to the neuronal level with sufficient physical properties will correlate with the interdependent mental powers. For such mental powers depend on bodily powers that need to be manifested via body parts with appropriate physical properties.

Moreover, the correspond body parts will be the same in Freddy as they are across the human species. This is due to FBR, the Aristotelian principle articulated just above that says the same type of form en-forming individual human bodies grounds biological regularities across the species. These regularities include macro biological regularities like sameness of organs such as a brain, as well as microbiological regularities such a neuronal structure and function.

When Freddy or any healthy developed human feels a bee sting, certain neurophysiological bodily powers are manifested – i.e. BP^{sting} – and particular body parts with sufficient properties manifest these powers. Specific to our focus is the power to receive and send a signal corresponding to the bee sting. This power is manifested by firing synapses in the peripheral nervous system (given the bee stung his foot), but also his central nervous system, which we can label N^{sting} . These firing synapses have the physical properties that manifest BP^{sting} , which correlates with Freddy manifesting his mental power to feel a bee sting – i.e. MP^{sting} . This mental power is manifested via Freddy’s conscious state of feeling a bee sting, which we can label C^{sting} . Putting this altogether, C^{sting} manifests MP^{sting} that is a correlated partner-power of BP^{sting} manifested via N^{sting} . Consequently, N^{sting} is the NCC of C^{sting} . And this NCC would be consistent throughout the human species comprised of members with the same type of form en-forming their human body.

6.2 The Model & Chalmers's Definition

For illumination, let us apply to our above example Chalmers's (2000, pp. 31) definition of an NCC:

An NCC is a minimal neural system N such that there is a mapping from states of N to states of consciousness, where a given state of N is sufficient, under conditions C , for the corresponding state of consciousness.

In our example the minimal neural system N is N^{sting} . And there is a mapping from N^{sting} to Freddy's conscious state C^{sting} of feeling a bee sting because the powers manifested by each (BP^{sting} and MP^{sting} respectively) are interdependent partner-powers that correlate with each other. And the same would be true of any healthy developed human manifesting C^{sting} , according to the model. The conditions C are background conditions, such as the heart pumping blood, that enable N^{sting} and C^{sting} (see Tononi and Koch 2015, p. 2).

To illustrate the account let us have \leftrightarrow represent the metaphysical interdependence between the active bodily power and the passive mental power. And \Leftrightarrow represent the resulting natural correlation between the neural process and the conscious state. In addition, let us have two vertical lines represent the bodily and mental powers being manifested through the corresponding neural processes and conscious state.

$$\begin{array}{ccc}
 N^{sting} & \leftrightarrow & C^{sting} \\
 | & & | \\
 BP^{sting} & \leftrightarrow & MP^{sting}
 \end{array}$$

On the bottom level, we have the active bodily powers manifested through the standard neural processes on the left side, and the passive mental power manifested through the conscious state on the right. These are the interdependent mind-body powers. On the top level, which is what we empirically study through neuroscience, we have the NCC represented. On the left is the neural correlate manifesting the bodily powers of the conscious state on the right that manifests the mental power.

Our diagram illustrates how the Mind-Body Powers model of NCC applies to our hypothetical scenario of Freddy's mental state and the corresponding neural correlate. Although Freddy is just a hypothetical healthy adult and the NCC is just hypothetical, if they were real this diagram would not just reflect Freddy's NCC. Because human bodies are en-formed by the same type of form that fixes standard biological bodily structures and functions, there is homogeneity across humanity in neurophysiology. Thus the diagram representing Freddy's NCC would reflect the same NCC across the human species.¹⁶ And the top level of the diagram would reflect a natural neurophysiological

¹⁶ While we can speak of homogeneity and sameness regarding neurobiology and NCC across a species, it is important to remember we are speaking of homogeneity regarding biological regularities that permit some degree of variation. Variations pertaining to NCC

regularity across humanity in the actual world. So the top double arrow (that is: \Leftrightarrow) would be representative of a natural biological regularity or law in our world.

However, it is important to note that \Leftrightarrow does *not* represent a strict relationship of either logical or metaphysical necessity. According to the definitions proposed by Chalmers (2000, pp. 31) and Koch et al. (2016, p. 307; cf. Mormann & Koch 2007), neural correlates are said to be sufficient for the correlated conscious state. But neither Chalmers nor Koch claim that neural correlates are logically or metaphysically necessary for the corresponding consciousness. Speaking as though a bee actually stung Freddy, \Leftrightarrow represents a metaphysically possible NCC that is an actual NCC in the actual world. But many philosophers think it is possible for beings such as animals or aliens with different neurophysiology than humans to have some of the same conscious states that humans have (see Kripke 1981; Putnam 1967).

According to this concept of multiple realizability, an alien with different neurons composed of different materials could be stung by a bee and have the same conscious state as Freddy (i.e. C^{sting}). Consequently, it would have a different NCC of the same conscious state. Given the possibility of multiple realizability, a viable account of NCC must be consistent with it and avoid ruling it out. In addition, there are cases where subjects lose a part of their brain with neural correlates of certain types of conscious states, but do to neuroplasticity a different part of the brain with different neurons begins to fulfill the same role (see section 5). Loosely speaking, this is like multiple realizability taking place in the same brain. Given such possibilities, it is important to keep in mind that \Leftrightarrow is not representing a relationship of logical or metaphysical necessity.

Rather, it represents the neurobiological reality that in the actual world the conscious state C^{sting} corresponds to the neural correlate N^{sting} in healthy developed human brains. Is it possible for a human person to undergo a brain injury and lose N^{sting} and yet have the same conscious state with a different neural correlate, say $N^{sting-alternative}$? According to neo-Thomistic hylomorphism, the answer is ‘yes’ as long as human neurophysiology allows for the possibility that C^{sting} correlate with $N^{sting-alternative}$ in cases of brain injuries or the like where N^{sting} is lost. Clearly there are cases of brain damage that result in a permanent loss of mental function and cases where it is possible for mental function to be regained as new neural correlates are established via neuroplasticity. As discussed above, such impossibility or possibility is ultimately grounded in the form of the human body (see section 5).

Is it possible for there to be an animal or an alien with a different form and thus different neurophysiology that is capable of having different neural correlates, N^{sting*} , of the same conscious state? Yes, according to my proposed model, as long as the neural correlates are the type of physical entity that can manifest the requisite bodily powers for the experience to be a bee sting. In such a case, there would be different bodily

can be due to variations in overall conscious experiences or variations in individual brains across a species.

neurophysiology capable of manifesting BP^{sting} that does so. For such a case a new diagram could be drawn that simply replaces N^{sting} with N^{sting*} .



According to this model, we do not know what neural states and processes are the correlates of particular conscious states. What we do know, assuming the model, is that the natural manifestation of MP^{sting} via C^{sting} requires the co-manifestation of BP^{sting} via some physical state or process that has the requisite characteristics to manifest BP^{sting} . And accordingly we can assume that there is such a physical state or process if we know that MP^{sting} is being manifested via C^{sting} . So there is strong motivation to find out just what physical process in the body is manifesting BP^{sting} . More precisely, there is good reason to do empirical investigation using the tools of modern neuroscience in search for NCC (cf. Moreland 2018, section I.2.1).

In summary, the metaphysical explanation of the correlation between C^{sting} and N^{sting} is that they manifest MP^{sting} and BP^{sting} , respectively, which are correlated partner-powers. Since the manifestation of the mental and bodily interdependent partner-powers correlate, the conscious state and neural processes that manifest these powers correlate. Thus according to the proposed model, the correspondence between consciousness and neural correlates is explained by the interdependence between active and passive powers of the mind and body. Therefore, the NCC studied by neurobiology are fundamentally grounded in the metaphysics of interdependent mind-body powers.

7 Conclusion

Aquinas (ST 1a 77.3c) claimed the human soul is "...at the boundary between spiritual and corporeal creatures, and consequently the powers of both come together in it." With this idea as a starting point, I have tried to construct a coherent metaphysical model of NCC based on Aristotelian causation. According to the Mind-Body Powers model of NCC, neural correlates of consciousness are explained by the interdependence of the mental and bodily powers co-manifested via the conscious state and its neural correlate. Since the mental power and bodily power are correlated given their mutual dependence as active and passive powers, their manifestations through sufficient neural processes and conscious states are correlated.

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