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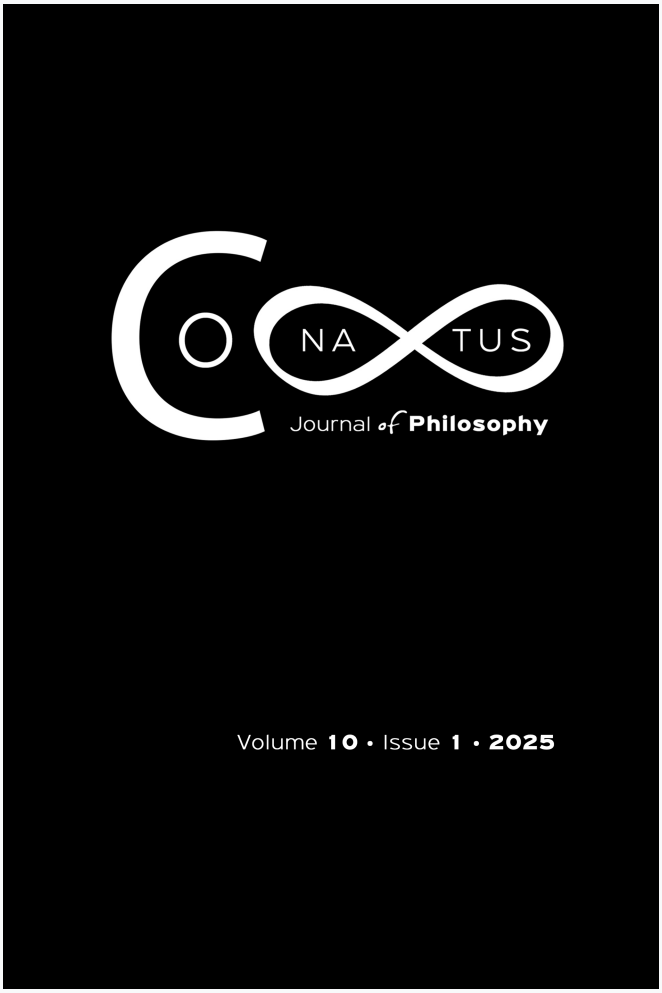

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What Does Self-control Look Like? Considerations about the Neurobiology of Temperance and Fortitude

Andy Mullins
University of Notre Dame Australia, Australia
E-mail address: apjm.vic@gmail.com
ORCID iD: https://orcid.org/0000-0003-1540-3796

Abstract

Our subject is the neurobiological characteristics of virtuous emotional responses and their integration into character. Drawing raw material from the self-reported thoughts and actions of Dr Takashi Nagai, present in Nagasaki at the time of the atomic bomb, our methodology is to conduct a highly granular examination of one specific moment where his self-control is greatly tested. This permits us then to offer an analysis of the neurobiological processes, pathways, and systems that underpin the management of emotional reactions, and in effect, draw insight into the neurobiology of virtues of temperance and fortitude, understood from an Aristotelian-Thomistic perspective. The neurobiological considerations are preceded by discussion of philosophical prerequisites founded on a Thomistic metaphysics of participation. In conclusion we offer some thoughts about the benefits of neurobiological investigations in relation to character and the aptness of the development of virtue for human beings.

Keywords: *Aristotelian-Thomistic virtue; emotion; neurobiology; self-control; atomic bomb; temperance; fortitude*

I. Introduction

Emotions are neither good nor bad in themselves, they are our responses to sense apprehensions. We are able to draw great good from them; they mediate relationships and our understanding of the world, and they are our primary motivators, but they require integration into our rationality. This integration is facilitated by the virtues, good habits of

responding to pain, pleasure, and the rights of others. Aristotle held that it was by these habits, the moral virtues, that "We are directed well or ill in reference to the passions."[1] The Aristotelian-Thomistic doctrine of the virtues offers a model for the successful integration of emotions, which it does not distinguish from passions, into character.[2]

The classical pre-eminence of the four cardinal virtues undergoes remarkable development in Aquinas's repackaging of Aristotle's vision of virtue within a psychology recognising essential powers each needing their own perfection by habit if we are to flourish: "Every power which may be variously directed to act, needs a habit whereby it is well disposed to its act."[3] These powers consist of the concupiscible and irascible sense appetites and the intellectual powers of knowing and choosing, and they each require their specific perfecting habit.[4] These habits are the cardinal virtues. When the sense appetites are activated, an emotion is manifested; emotions are a response to sense apprehensions of whatever we find pleasant or arduous. The habits perfecting the sense appetites are temperance and fortitude, and those perfecting intellectual operations are prudence, and justice which Aquinas identifies as the virtue of the will, wherein every choice must take into account the rights of others.

When our emotional responses have become habitually malleable to reason, we are said to have developed the virtues of temperance and fortitude. Temperance is the habitual pursuit of pleasures reasonably assessed as good for us, and fortitude, the habitual readiness to overcome fear of difficulty for a good reason. These virtues are seen as the engine room of self-control.

For this discussion of the neurobiology of virtue I adopt this Aristotelian-Thomistic understanding of virtue. In distinguishing between sense appetites relating to pleasure and pain, and intellectual powers, possibilities open for a neurobiological discussion of the neural reformation of those appetites.

This doctrine has proven remarkably resilient as a model for human personality. Not only does it appear to accord with human experience, and the wisdom of religious and secular literature, but it is evident across all cultures. Classical virtue is now incarnated in contemporary virtue ethics and contemporary positive psychology, whereby the neurobiological systems and

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[1] Aristotle, *Nicomachean Ethics*, II.5,1105b29.

[2] As nuances in the nature of emotion are not the focus of this paper, I will adopt an Aristotelian focus on emotion, without entering into contemporary debates about the nature of emotion.

[3] Aquinas, *Summa Theologica* (*S.T.*), I II 50.5.

[4] Ibid., I II 61.2. Previously he has explained: "Every power which may be variously directed to act, needs a habit whereby it is well disposed to its act." (*S.T.*, I II 50.5). The four powers of concupiscible and irascible appetites, rational will, and intellect, all require their specific perfecting habit. These habits are the cardinal virtues.

processes of virtuous behaviours are being identified. This will constitute the focus for this paper. However, my starting point will be close observation of a one precise moment of heightened emotion and subsequent self-control. By this approach, I hope to reinforce the conviction that virtues are not theoretical, albeit coherent, constructs for understanding behaviour, but manifest objective attributes of the person that facilitate behaviours which are good for us as human beings.

II.

a. Takashi Nagai (1908-1951)

We anchor our discussion of self-control in the real world of sensation, passion, apprehension, deliberation, choice and action of Dr Takashi Nagai, in the early days of August 1945 in Nagasaki. We recall Elizabeth Anscombe's advice that, before we lose ourselves in ethical theory, we must account for the richness and complexity of real people who manifest the tension between rationality and emotion, free and impulsive behaviours, intrinsic and extrinsic motivation, and fulfilled and unfulfilled lives.[5]

Nagai is an exemplary figure; a medical doctor and nuclear physicist who, in the years after WWII, through his writings under the most difficult circumstances, was a great force for spiritual healing in a country gutted by the horrors of war.[6] Nagai's response to the cataclysmic event of August 9, 1945, led to his subsequent fame. His personal account of the immediate aftermath of the blast in Nagasaki became a best seller in Japan, and the subject of movie and popular song. He wrote some twenty books in the six years after the war.

Nagai demonstrated that he was a man of deep convictions and intelligence, concern for his fellow man, austerity of life, and courage. Greatly influenced by Pascal's *Pensées*, by his wife and perhaps also by his experiences with the Imperial Army during its invasion of China, Nagai had become a Christian before the war. He was a devoted father and compassionate doctor; zealous for the advancement of medicine, he carefully documented the effects and effective treatments of radiation illness. Through all his suffering he manifested no bitterness towards the Americans for the bombing that destroyed millions of lives, and in some estimates, half the urban areas of Japan. In post war Japan during the six years as he lay dying of leukemia, Nagai

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[5] Elizabeth Anscombe, "Modern Moral Philosophy," in *Virtue Ethics*, eds. Roger Crisp and Michael Slote (Oxford University Press, 1997), 26.

[6] Introductory texts for an understanding of Takashi Nagai's life: Takashi Nagai, *The Bells of Nagasaki,* trans. William Johnston (Kodansha America Inc, 1994); original title: *Nagasaki no kane* (1949). Paul Glynn, *A Song for Nagasaki* (Marist Fathers Books, 1988).

rose to prominence as a national spiritual leader as much for his extraordinary writings encouraging reconciliation and peace, as for his remarkable humility and inner peace.

> In the postwar years Nagai became a symbol of strength and optimism, a central figure in the spiritual and moral reconstruction of Japan. [...] His influence on the collective unconscious of Japan was very great.[7]

He was praised in the contemporary press as the "Gandhi of Japan." The nobility of Nagai's mature, considered actions and the richness of his emotional life typify what most would agree to be a state of virtue.

b. 11.02 am August 9, 1945

On the morning the bomb fell, Nagai was at work in his bunkered laboratory, 500m from the epicentre, choosing X-ray films to teach students the art of diagnosis. Without warning there was a flash of blinding light. With observational skills honed by scientific training, Nagai described his own experience:

> I immediately tried to throw myself to the ground, but before I could do so, the glass of the windows smashed in and a frightening blast of wind swept me off my feet into the air – my eyes wide open. Pieces of broken glass came in like leaves blown off a tree in a whirlwind. I felt that the end had come. [...] It was as though a huge invisible fist had gone wild and smashed everything in the room. The bed, the chairs, the bookcases, my steel helmet, my shoes, my clothes were thrown into the air, hurled around the room with a wild clattering noise, and all piled on top of me as I lay helpless on the floor. Then the blast of dusty dirty wind rushed in and filled my nostrils so I could scarcely breathe. I kept my eyes open, looking always at the window. And as I looked everything outside grew dark. There as a noise like a stormy sea, and the air everywhere swirled round and round. My clothes, the zinc roof, pieces of wood, and all kinds of other objects were performing a macabre dance in that dark sky. Then it gradually became cold, as at the end of autumn, and a strange and silent emptiness ensued. Clearly this was no ordinary event.[8]

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[7] William Johnston in the preface of Nagai, *Bells,* xx and xxii.

[8] Nagai, *Bells,* 11.

Everywhere there were the dead and dying, convulsing, strangely swollen, skin peeling. Soon fires were raging. Weakened by previously contracted leukemia, and despite his own grave injuries, Nagai worked to utter exhaustion caring for the dying and injured through the day of the blast and the days that followed. He had to improvise everything. Only after three days did he return to his family home finding the charred bones and melted rosary of his beloved wife, Midori.

c. Tested self-control

Nagai's capacity to describe with precision internal states and subjective responses, as well as external events, make his writing ideal for the purposes of this study. On the day following the blast, he describes one moment in which, despite exhaustion and discouragement, he demonstrates the process of mastering impulsive emotion. In this excerpt he captures the moment when the reality dawns upon him that the destruction was wrought by a nuclear device and consequently Japan must be defeated:

> The chief nurse came running up and handed me a sheet of paper. It was one of the leaflets dropped by enemy planes the previous night. As I glanced at it I shouted out spontaneously: "The atomic bomb!" In the depth of my being I felt a tremendous shock. The atom bomb has been perfected! Japan is defeated! [...] Conflicting emotions churned in my mind and heart as I surveyed the appalling atomic wasteland around me. [...] A bamboo spear lay on the ground. I kicked it fiercely and it made a dull, hollow sound. Grasping it in my hand, I raised it to the sky, as tears rolled down my cheeks. The bamboo spear against the atomic bomb! What a tragic comedy this war was! This was no longer a war. Would we Japanese be forced to stand on our shores and be annihilated without a word of protest? These are the words written on the leaflet:
>
> *To the People of Japan*
> *Read carefully what is written in this leaflet. The United States has succeeded in inventing an explosive more powerful than anything that has existed until now. The atomic bomb now invented has a power equal to the bomb capacity of two thousand huge B-29s. You must reflect seriously on this terrible fact. We swear that what we say here is the solemn truth. [...] The President of the United States has already given you an outline of thirteen conditions for an honourable surrender. We advise you to accept these conditions and to being rebuilding a new and better peace-*

> *loving Japan. [...] If you do not do this, we are determined to use this bomb and other excellent weapons to bring this war to a swift, irresistible conclusion.*
>
> I read the leaflet once and was stunned. I read it a second time and felt they were making fools of us. I read it a third time and was enraged at their impudence. But when I read it a fourth time I changed my mind and began to think it was reasonable. After reading it a fifth time I knew that this was not a propaganda stunt but the sober truth.[9]

This moment brings the thunderclap insight that the war is now inevitably lost. It is interwoven with a sense of the burning shame, associated with any defeat, inculcated by his culture since childhood. Nagai's description of how his passionate reaction subsides on successive readings of the leaflet gives us a remarkable insight into how deliberation can enable mastery of passion. What is initially less obvious is the interior battle that Nagai has to fight in order to respond rationally to the news. Had he torn up the leaflet after the first readings, he would not have come to the same conclusion. Unsaid too is any reference to his education and upbringing that empowered him to exhibit the self-control required to allow the news to sink in.

His acceptance of the truth about the bomb is followed by very swift reasoning and insight that the Japanese defenders would be powerless on beaches against landings supported by atomic weapons. He then deliberates over whether he should accept the demand of the leaflet. Only in his fourth reading he "changes his mind" and now finds the words "reasonable." Grasp of one truth leads to deliberation and reasoning that leads to the grasp of another truth. During the period of deliberation he keeps his emotions under control sufficiently to continue his deliberation.

Complexity is further added by the fact that, although it is not explicitly stated in this passage, he is aware he has an audience. By his leadership and decision making throughout the previous day, he had already demonstrated an appreciation of his responsibility to those suffering around him. It is reasonable to surmise that this sense of responsibility as well as his military and scientific training assisted him in applying sufficient deliberation before committing himself to judgement.

d. Distilling temperance

In the example above, Nagai strives to harmonise his emotional responses with his reason; he chooses to react to his emotion in a way that permits

[9] Ibid., 52-53.

him to grasp the objective truth of the situation in which he finds himself. Only on the fourth and fifth readings did he accept the truth of what he was reading. This effort to confront something deeply unpalatable bespeaks qualities of character and a habitual restraint that withholds final judgement and continues deliberation without committing to an unbridled emotional response until a matter has been thoroughly considered. It illustrates well the capacity for passionate reactions schooled (or "conditioned," to use a term applicable to neural responses) to accept the guidance of reason, albeit with initial reluctance. We are witnessing the effects of the already acquired habitual disposition in Nagai's sensitive appetites to respond to his direction. Also, we see in his rational appetite, his capacity to make well deliberated choices responsive to the rights of others. This is the very stuff of virtue. Aristotle and Aquinas both hold that our appetites, both sensible and rational, need to have been trained if a person is to possess such restraint and self-control as we see in Nagai. Yet, every subsequent virtuous action, further reinforces the earlier disposition.

We witness the evident interplay of the cardinal virtues in this internal dialogue. Nagai draws on habitual management of impulse (temperance), as well as a habitual readiness to apply himself in a difficult situation (fortitude), along with a habitual sense of duty to countrymen and country (justice), and an openness to truth and readiness to reflect (prudence). All is at the service of actions informed by reality. In such a moral dissection, the unity of the virtues appears virtually self-evident.

By mastering his humiliation and anger to consider the implications of the Allied leaflet, Nagai demonstrates how fundamental to human existence are the dual challenges of curbing wayward internal passions and overcoming external difficulties in the pursuit of difficult goals.

Aristotle places the cultivation of man's passions at the very heart of human appetition: to seek pleasure and avoid pain. At this most elemental level, temperance in response to hedonism, and fortitude in response to fear and pain, are dispositions to self-mastery. He explains that pain and pleasure enter into *both* temperance and fortitude.

> The self-indulgent man craves for all pleasant things or those that are most pleasant, and is led by his appetite to choose these at the cost of everything else; hence he is pained when he fails to get them and when he is merely craving for them (for appetite involves pain).[10]

[10] Aristotle, *Nicomachean Ethics*, III.1, 1119a1-5.

And direction of our sensitive appetites is the very matter of daily life.[11] Aquinas stressed that these emotional responses are positively good but only if they are managed by reason.

> Emotion leads away from moral behaviour in so far as it is uncontrolled by reason; but in so far as it is rationally directed, it is part of the virtuous life.[12]

III. Metaphysical pre-requisites

A discussion of the biophysical bases of self-control should be conducted within a sufficient philosophical anthropology. Purely physicalist notions of rationality seem inadequate. Roger Scruton has noted,

> [T]here is a problem about accounting for rationality and the general difference between man and the other animals [...] in the end we need some kind of teleological metaphysics to make sense of our condition.[13]

Human beings have the capacity to act for ends that transcend sense experience. If this view is accepted, rational processes may not be reduced to electrical impulses, chemical processes, neural systems and pathways and brain regions. Human rationality may not be reduced to processes of reasoning, or to subjective inner life, qualia, consciousness, or other subjective manifestations. Indeed, John Haldane questions the possibility of consciousness studies offering a way forward in philosophy of mind.[14] Ultimately human maturity seems inseparable from the capacity to know reality and make choices, and to find fulfilment in interpersonal loving relationships, life self-directed intentionally for others. "Human beings have the capacity to understand their world, and at the same time, to stand above it, to seek fulfilment in elective, loving relationships with other rational beings."[15] This understanding of rationality seems essential, of the essence, to what it means to be human.

a. A Thomistic metaphysics of participation

It is beyond the scope of this paper to enter in any depth into the great variety of views on rationality. A teleological metaphysics of participation within

[11] Ibid., III.2, 1111b13-16.

[12] Aquinas, *S.T.*, I II 24.2.

[13] Andy Mullins, "Can Neuroscientific Studies Be of Personal Value?" *International Philosophical Quarterly* 57, no. 4 (2017): 444.

[14] John Haldane, "A Return to Form in the Philosophy of Mind," *Ratio* 11, no. 3 (1998): 253-277.

[15] Andy Mullins, "Philosophical Prerequisites for a Discussion of the Neurobiology of Virtue," *Ethical Perspectives* 23, no. 4 (2016): 689-708.

hylomorphic personalism offering an adequate philosophical underpinning for a discussion respecting both evident freewill and the evidence of neurobiology in supporting human activity is a Thomistic metaphysics of participation (TMP). Within TMP,

> Rationality should not be seen as a ghostly process exclusive of the world of matter, but rather as a transcendent process within matter itself by virtue of a participated power.[16]

I will offer an overview of TMP, drawing some contrasts with non-reductive physicalism and with hylomorphic approaches that manifest dualism.

Such a metaphysics of participation *in esse subsistens* has been absent from philosophy of mind and is found only, more broadly in Anglo-American Thomism, in the work of philosophers such as Norris Clarke, Koterski,[17] Wippel,[18] Hankey,[19] and Cullen.[20] The Thomistic argument for rationality commences with a grasp of the contingency of living things, and of rational subjects in particular. It is dependent upon the close attention to reality, the "complex materiality of things" alluded to by Martha Nussbaum.[21] Aquinas' argument for the inadequacy of the physical to account for intellectual life, "no corporeal power can produce the intellective soul"[22] is founded on the principle: "the greater is not brought about by the lesser, for nothing acts outside its species."[23] Utilising a simile, he emphasised the metaphysical and existential dependence on a first cause: "the form of fire emerges when the fire itself is produced."[24] His argument for the necessity of participation in being is drawn from contingency. First, he notes that existence and essence are distinct notions:

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[16] Andy Mullins, "A Thomistic Metaphysics of Participation Accounts for Embodied Rationality," *International Philosophical Quarterly* 62, no. 1 (2022): 83.

[17] Joseph W. Koterski, "The Doctrine of Participation in Thomistic Metaphysics," in *The Future of Thomism*, eds. D. Hudson and D. Moran (University of Notre Dame, 1992), 185-196.

[18] John F. Wippel, *The Metaphysical Thought of Thomas Aquinas: From Finite Being to Uncreated Being* (The Catholic University of America Press, 2000).

[19] Wayne J. Hankey, "Placing the Human: Establishing Reason by Its Participation in Divine Intellect for Boethius and Aquinas," *Res Philosophica* 95, no. 4 (2018): 583-615.

[20] Christopher M. Cullen and Franklin T. Harkins, eds., *The Discovery of Being & Thomas Aquinas: Philosophical and Theological Perspectives* (Catholic University of America Press, 2019).

[21] Martha C. Nussbaum and Hilary Putnam, "Changing Aristotle's Mind," in *Essays on Aristotle's De Anima*, eds. Martha C. Nussbaum and Amélie Oksenberg Rorty (Clarendon Press, 1995), 56.

[22] Aquinas, *The Summa Contra Gentiles (S.C.G.),* 2. 86.7.

[23] Aquinas, *S.T.,* III 79.2 ad3.

[24] Aquinas, *S.C.G.*, 2. 87.3.

> Every essence or quiddity can be understood without understanding anything about its existence: I can understand what a man is or what a phoenix is and nevertheless not know whether either has existence in reality. Therefore, it is clear that existence is something other than the essence or quiddity.[25]

These contingent living things require a principle of being, unity, and operations; this is the soul. This is evident because at death there is not only dissolution of material unity, but also of the subject, who once present has departed, despite the fact that the component material elements remain. At death this principle of unity is lost. Aristotle regarded the soul as the principle of activities following on the nature of the living substance, but Aquinas argued that the soul must be principle of existence.[26]

Note that Roger Scruton above referred specifically to the need to account for the difference between man and other animals. There is no objection that animal souls emerge from matter. But because rational subjects act with a certain immateriality of thought and with a certain freedom of will, which are operations that transcend matter, Aquinas argued that a rational soul cannot have emerged from matter. Therefore, the rational subject must receive being and its operative powers from beyond, or receive a sharing in such powers. By reflection on the contingency of human intellectual subjects, we deduce the necessity of a principle of participation in being, through which rationality being an essential property of human nature, is shared, or bestowed also in some way from another source.

Existence is through the *actus essendi* of the human soul, the principle of contingent existence, unity, and function, which participates in Being, *in esse subsistens*, that Norris Clarke calls "the Ultimate Source."[27] Fabro regarded participation *in esse subsistens* as the key to Aquinas' metaphysics: "It is from the concept of *esse* as ground-laying first act that Thomas develops his own notion of participation and his entire metaphysic."[28]

Moving beyond Aristotle's reservations,[29] Aquinas recast the Neoplatonic notion of participation into a highly original synthesis

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[25] Aquinas, *De ente et essentia*, IV.

[26] Aquinas, *S.T.*, I 3.4.

[27] William N. Clarke, S.J. *The One and the Many: A Contemporary Thomistic Metaphysics* (University of Notre Dame Press, 2001), 87.

[28] Cornelio Fabro and B. M. Bonansea, "The Intensive Hermeneutics of Thomistic Philosophy: The Notion of Participation," *Review of Metaphysics* 27, no. 3 (1974): 463.

[29] Aristotle, *Metaphysics,* X.5-6, 1056b4-1057a15.

proposing essence and existence to be really distinct.[30] To it he applied the notion of act and potency to being, giving primacy to the act of being. "All other beings that are not their own being but have being by participation must proceed from that one thing,"[31] and elsewhere, "That which has existence but is not existence, is a being by participation."[32] He presented *esse* as *actus essendi*, in contrast to *existentia* of Augustinianism and of rationalism, and presented form not only as a principle of function or unity, but as a participation *in esse subsistens*.

> In the Platonic tradition, the term "participation" signifies the fundamental relationship of both structure and dependence in the dialectic of the many in relation to the One and of the different in relation to the Identical, whereas in Christian philosophy it signifies the total dependence of the creature on its Creator.[33]

The consistently underlying presence of participation in the thought of Aquinas,[34] came to light in the mid-twentieth century through the work of Fabro, Gieger and others. In line with the sixteenth century commentator Dominic Banez, Fabro drew attention to Aquinas' primacy of subsistent being.

> It is not man who determines Being and imposes it on its varied forms, since it is through Being and in view of, that is, because of, Being that man works in the world.[35]

He regarded the dialectic of participation as "the hermeneutic key of the originality of Thomism."[36]

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[30] Cornelio Fabro, "Platonism, Neo-Platonism and Thomism, Convergencies and Divergencies," *The New Scholasticism* 44, no. 1 (1970): 69-100.

[31] Aquinas, *De potencia* Dei, 3.5.

[32] Aquinas, *S.T.,* 1.3.4.

[33] Fabro and Bonansea, "The Intensive Hermeneutics of Thomistic Philosophy," 449.

[34] Thomas A. Fay, "Participation: The Transformation of Platonic and Neoplatonic Thought in the Metaphysics of Thomas Aquinas," *Divus Thomas* 76 (1973): 50-64.

[35] Cornelio Fabro, "The Problem of Being and the Destiny of Man," *International Philosophical Quarterly* 1 (1961): 407.

[36] Cornelio Fabro, *Esegesi Tomistica* (Libreria Editrice della Pontificia Università Lateranense, 1969), xxxiii.

b. Features of such a view of rationality[37]

i. Rationality and intellect are by participation

Within TMP, rationality is mediated by, but not reducible to, physical processes. Phantasms are made actually intelligible by the active intellect. This active intellect consists of immaterial and intelligible species and is a participation in "Divine light."[38] This point is crucial: the intellect is a participated power, a power not properly its own, but one which "belongs to another fully."[39]

Aquinas argued that goodness and truth participate in Being. Human subjects possess being, and rationality, both *by participation*. "It is necessary that that which is greatest in being and truth be the cause of being and truth in all other beings."[40] It can only be through participation in being, that non-material perfections of the Ultimate Source – the capacity to know (to grasp reality) and to will (to love on the basis of intellectual choice) – are present in the particular as essential properties.[41] The essential operations of knowing and choosing are present also by the same act of being. Aquinas notes in *De Veritate* how being also underpins knowing:

> [...] a thing is apt to be conformed (adaequari) to the intellect in the degree to which a thing has entity (entitas). Consequently, the notion of truth follows upon that of being.[42]

In the hierarchy of being, the intellectual enjoy "intensified substantiality" through richer participation in being. As a consequence they are capable of "immanent and spontaneous activity."[43] Only on a ground of participation in Being from an Ultimate Source, may unity and rationality of an intellectual subject be safeguarded.

From this it follows that rationality is not just a process or one human activity among others, but it is an *essential* mark of human nature, inseparable, not because an individual human being always acts rationally, but because human nature is rational. It is an essential truth about human beings.

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[37] This view is developed and argued in Andy Mullins, "Rationality and Human Fulfilment Clarified by a Thomistic Metaphysics of Participation," *Scientia et Fides* 10, no. 1 (2022a): 177-195, and Mullins, "A Thomistic Metaphysics of Participation Accounts for Embodied Rationality."

[38] Aquinas, *S.T.*, I 89.1, and I 84.6.

[39] Aquinas, *Expositio* 1.2, cited in Fabro and Bonansea, "The Intensive Hermeneutics of Thomistic Philosophy," 454.

[40] Aquinas, *De substantiis separatis,* 3. 58.

[41] William N. Clarke, S. J. *Explorations in Metaphysics: Being-God-Person* (University of Notre Dame Press, 1994), 65ff and 89ff.

[42] Aquinas, *Questiones disputatae de Veritate*, 1.1 ad 5.

[43] Juan E. Carreño, "From Self Movement to Esse: The Notion of Life and Living Being in Thomas Aquinas," *Angelicum* 92, no. 3 (2015): 347-376.

ii. Mental life all mediated by, but not reducible to, the biophysiological

TMP finds common ground with physicalist non-reductive and emergent accounts. TMP supports the view that in the human subject there is an immaterial life of the mind underpinned in all operations by embodied neural bases. In TMP, biophysiology is the material cause of the operations of rationality: "intellectual knowledge is caused by the senses [...] it is in a way the material cause."[44]

> In the present state of life in which the soul is united to a passible body, it is impossible for our intellect to understand anything actually, except by turning to the phantasms.[45]

iii. An enriched notion of rationality

So, by means of its participation *in esse subsistens,* TMP is able to distinguish the embodied rational person from non-human-animal natures. Rationality is seen as an essential quality of human life. Even if high level cognitive processing should emerge from matter, those behaviours would be one more competing feature or behaviour among others. In this way, the processes, structures and systems of reasoning and mental life are not seen as defining features of rationality, but signs that rationality may or may not be present.

Here too the Thomistic notion of a participative active intellect is of great importance. According to the TMP account, in contrast with essentialist metaphysical systems like that of Aristotle himself, essence and its primary constituent, form, do not play the role of primary repositories of perfection, but take on rather the secondary, derivative role of principles of limitation.[46] Human nature is actualized through participation *in actus essendi*, but limited by the human essence, and so too, the power of intellection, as an essential property of participating being, is bestowed from without.

iv. Teleological implications for the human subject[47]

Within TMP and a Thomistic understanding of the transcendentals, truth is grounded in being, *in esse subsistens*. Rationality is seen as essential property of the soul. The operations of rationality make possible human fulfilment in truth and love. Non-reductive physicalist accounts cannot discuss such

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[44] Aquinas, *S.T.*, 1.84.6.

[45] Ibid., 1.84.7.

[46] Clarke, *Explorations in Metaphysics*, III.

[47] See extended discussion of these notions in Mullins, "Rationality and Human Fulfilment Clarified by a Thomistic Metaphysics of Participation."

fulfilment as essential, because they offer no basis to prioritise the operations of rationality over other activities.

Thereby TMP provides a coherent account of the capacity for human beings to grasp truth and universal concepts, to make love choices based on these truths. Walker offers philosophical arguments, developed from a communitarian Thomistic perspective, for the view that integral to rationality are loving relationships: that human persons by their very nature are fulfilled in personal loving relationships.[48]

c. Not all hylomorphic anthropology recognises participation in being as the decisive factor. Challenges faced by current Anglo-American philosophy of mind.

By arguing that the immaterial life of the mind correlates with, but is not reducible to, embodied neural bases TMP is free of any taint of dualism which is anathema to contemporary neuroscience, summed up in the words of Nobel laureate Eric Kandel: "Philosophically disposed against dualism, we are obliged to find a solution to the problem in terms of nerve cells and neural circuits."[49] These immaterial operations of rationality are transcendent operations carried out by ensouled matter through a participated power, at all times mediated by the biophysical. Thus unity of the subject in the embodied rational person is defended, and substance dualism, indeed all dualism, is avoided.

On the other hand, when hylomorphic arguments for immaterial properties proper to a human being have been framed on the basis of formal causality, there has been a tendency by the advocates themselves, to frame the operations of the intellect in dualistic terminology. This dualism arises because of a different understanding of "immateriality of the soul." TMP views the active intellect as a participated power and not a formal or constitutive principle, to use the terminology of Fabro.[50] Instead of accounting for immateriality through this participated power, an abstracting "non-physical" faculty,[51] proper to the soul, is proposed. This becomes the "formal or constitutive

[48] Adrian J. Walker, "Personal Singularity and the *Communio Personarum*: A Creative Development of Thomas Aquinas' Doctrine of *Esse Commune*," *Communio* 31, (2004): 457-479.

[49] Eric R. Kandel, James Harris Schwartz, and Thomas Jessell, *Principles of Neural Science* (McGraw-Hill, 2000), 1317.

[50] Cornelio Fabro, *La Nozione Metafisica di Partecipazione Secondo S. Tommaso d'Aquino* (Società editrice internazionale, 1950), 272-273. Reference in Jason A. Mitchell, "Being and Participation: The Method and Structure of Metaphysical Reflection according to Cornelio Fabro" (PhD diss., Pontifical Athenaeum Regina Apostolorum, 2012).

[51] James D. Madden, *Mind, Matter, and Nature: A Thomistic Proposal for the Philosophy of Mind* (The Catholic University of America Press, 2013), 671.

principle" of the intellect,[52] whose operations of "could not be powers actualized in matter."[53] In this way, rather than looking to the infinite Source itself to explain intellectual life, we look to constituent faculties of the human being.

Significantly all the important contemporary Anglo-American texts in *hylomorphic* philosophy of mind that have been published in recent years, including major works by Feser,[54] Madden,[55] and Jaworski,[56] adopt an exclusive focus on the formal causality of the human soul and omit discussion of participation, although Madden makes one reference without elaboration to "ontological causality." Jaworski stands in greater contrast by his primary focus on the structure bestowed by form. Other recent relevant works feature what could be described as an essentialist approach more akin to Aristotle than to Aquinas.[57]

Formal causality without participation is susceptible to the critique of dualism because it downplays full embodiment and suggests immaterial agency. Both Feser and Madden suggest that immateriality of the soul demands a form of property dualism. But as Lycan has argued, how is the property dualist solution not a substance dualist solution.[58] Property dualism risks being an assertion without a coherent explanation. D. M. Armstrong has also picked this up when he noted the "considerable difficulty and confusion which surrounds the philosophical theory of properties," and how this poses a challenge for the "one substance view" which includes hylomorphism.[59]

Without a paradigm of participation, dualism in some form is inevitable if one wishes to preserve the enriched understanding of rationality discussed above. But resort to dualism shuts down the conversation with advocates of non-reductive physicalist and emergent accounts. TMP is able to engage with emergent accounts as both are wholly embodied. In both, the biological mediates all intellectual operations of the embodied subject; but also, as we have seen, TMP offers the advantage of a teleological metaphysics that supports the unique nature of human life.

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[52] Fabro, *La Nozione Metafisica di Partecipazione*, 272-273.

[53] Madden, *Mind, Matter, and Nature,* 254.

[54] Edward Feser, *The Philosophy of Mind: A Short Introduction* (Oneworld Publications, 2005).

[55] Madden, *Mind, Matter, and Nature*.

[56] William Jaworski, *Structure and the Metaphysics of Mind: How Hylomorphism Solves the Mind-Body Problem* (Oxford University Press, 2016).

[57] Kathrin Koslicki, *Form, Matter, Substance* (Oxford University Press, 2018).

[58] William G. Lycan, "Is Property Dualism Better off than Substance Dualism?" *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 164, no. 2 (2013): 533-542.

[59] D. M. Armstrong, "Mind-Body Problem: Philosophical Theories," entry in *The Oxford Companion to the Mind,* ed. Richard L. Gregory (Oxford University Press, 2006).

IV. Distilling the neurobiology[60]

Because real-time brain imaging has only been possible since the 1980s, the neurobiological descriptions that follow are hypothetical but thoroughly founded on current research into neurobiological mechanisms, pathways, systems and regions. The originality of this paper is to synthesise this knowledge into an account of the neural bases of a virtuous action. For the sake of clarity I will analyse the sequence of events into eight segments. The principal neurobiological players in the description below are the *prefrontal cortex* (PFC), acknowledged as mediating consciousness. Within the PFC, the *orbitofrontal cortex* (OFC) and the *ventromedial PFC* (VMPFC) are associated with consciousness of emotion, and the *dorsolateral prefrontal cortex* (DLPFC) with conscious regulation of emotion. The *limbic system*, and especially the *amygdala*, play a major role in mediating emotional response and memory. The *basil ganglia* (BG) including the *striatum*, the *nucleus accumbens* (NA), and the *substantia nigra* (SN) is now recognised as playing a major role in linking centres for emotion, reward, and both conscious and unconscious habit formation. *Dopamine* (DA) is a neurotransmitter associated with attention, and reward. Note too that in the course of moral evaluations and judgements there is a complex integration of numerous neural subdivisions which show significantly consistent activation across numerous studies.[61]

a. "The chief nurse came running up and handed me a sheet of paper"[62]

Nagai has already demonstrated that he has finely attuned responsibilities to those he leads, and habitual courtesy. He takes the leaflet from the nurse, conscious of his duties towards her. It is reasonable to surmise that this sense of responsibility as well as his training in scientific objectivity assisted him in applying sufficient deliberation before committing himself to judgement. Pre-established habits of professionalism dispose Nagai to take his duties to the nurse and to the survivors seriously. He will be aware of the importance in this crisis of giving appropriate example and reaching a final deliberation in the best interests of the entire community he now finds himself leading. The principle evident in his actions is that truth, no matter how unpalatable,

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[60] It is beyond the scope of this paper to justify the implication of the neurobiological systems, pathways, and processes discussed. Data accords with standard reference neurobiological texts such as Larry Squire et al., eds., *Fundamental Neuroscience* (Elsevier, 2008); Kandel et al., *Principles of Neural Science*; Mark F. Bear et al., *Neuroscience. Exploring the Brain* (Lippincott Williams and Wilkins, 2007). For complete text and research papers references see Andrew P. J. Mullins, "An Investigation into the Neural Substrates of Virtue to Determine the Key Place of Virtues in Human Moral Development" (PhD diss., University of Notre Dame Australia, 2012).

[61] Mullins, "Can Neuroscientific Studies Be of Personal Value?" 448-451.

[62] Nagai, *Bells,* 51.

must be faced and for a leader to do so is necessary. Prior learning of duty and courtesy, both disposed by justice, lead Nagai to respond to the nurse's implicit request to read the leaflet.

Nagai is extremely drained and exhausted as it is the day after the bomb has exploded. He has suffered much blood loss and has lost consciousness at least on one occasion. The need to care for the wounded has given him little rest. He is also fatigued from the responsibility of leading the growing group of survivors. Exhaustion will be manifested in lower levels of attention, a heightened capacity for emotionally initiated representations (an overactive imagination), and difficulty in suppressing goal irrelevant sensory inputs. When Nagai is approached by the nurse and becomes aware of the American leaflet, his *fronto-parietal attentional system* is triggered. *Acetylcholine* (Ach) from the *nucleus basalis* is released into the *thalamus* and into areas of the *parietal, frontal and cingulated cortices*, heightening attentiveness. Attentional loops between the BG and the cortex are established. DA, a facilitator of attention, is also activated for emotional and reward responses.[63]

b. "In the depth of my being I felt a tremendous shock. The atom bomb has been perfected! Japan is defeated!"[64]

Nagai's description of how his passionate reaction subsides on successive readings of the leaflet gives us a remarkable insight into how deliberation can enable mastery of passion. What is initially less obvious is the interior battle that Nagai has fights in order to respond rationally to the news. There is an initial movement of complacency towards the truth. He comprehends the American claim and reacts initially dispassionately.

As Nagai glances at the leaflet initial visual input is channelled to the *basolateral complex of the amygdala* (BLA) from the *sensory nuclei of the thalamus* which has filtered out other inputs allowing his full attention on the leaflet. A degree of fear conditioning will be evident in the BLA given the suffering that Nagai has endured. There is an initial numbness, a lack of cortical response associated with a welling sadness (perhaps reflecting a left VMPFC that is underactive in managing right side negative affect), but Nagai falls back, perhaps heightened through his training as a scientist, on an established habit of seeking knowledge. He reads in the text a confirmation of his suspicions of a nuclear blast. His scientific knowledge gives him virtually

[63] Note that it can be only the person as the subject of the action when we are considering a human act. However, when we are not referring to a human act, but to unconscious responses by parts of the body (e.g. ACh heightens attentiveness) or to the action of part of the body (e.g., my eye blinked, my amygdala responded to emotional input), I adopt the convention of specifying a non-personal subject.

[64] Nagai, *Bells,* 51.

an intuitive grasp of the potential of such a bomb. Cortical representations of sadness for his country and people, and disgust at the Americans, flood his cortical memory and a negative emotional state overwhelms reason. Even in a state of physical and psychological exhaustion, Nagai's learned self-mastery is sufficient for him to utilise cognitive pathways to gain some management of passionate predisposition, reacting with deliberation, and consideration of consequences.

c. "[...] Conflicting emotions churned in my mind and heart as I surveyed the appalling atomic wasteland around me. [...] A bamboo spear lay on the ground. I kicked it fiercely and it made a dull, hollow sound. Grasping it in my hand, I raised it to the sky, as tears rolled down my cheeks. The bamboo spear against the atomic bomb! What a tragic comedy this war was! This was no longer a war. Would we Japanese be forced to stand on our shores and be annihilated without a word of protest?"[65]

Conflicting emotions well up within him, of frustration, sadness, anger, patriotism, and shame at defeat. He deliberates briefly about the prospects of victory for Japan in the face of nuclear weapons and concludes there is no hope of victory. He remains resilient to blind passionate assertion. Prudence disposes his readiness to apply himself diligently to assess the truth of the American claims. Justice ensures that does not dismiss the American claims out of hand.

Initially we are witnessing a "low road"[66] emotional response unmediated by the cortex. Although there is consciousness in the PFC of the response, there is little cortical processing. A further surge of emotional memory inputs flood into the BLA via reciprocal connections to the *hippocampal and striatal memory systems*. There are neural activations of fear, sadness, anger and disgust (in the *anterior insula*). Outputs from the BLA trigger a rage response in the *dorsomedial nucleus of the hypothalamus*. This hypothalamic response directs rage related motor patterns. The various limbic aversion centres also activate. Limbic afferents to the PFC via the OFC trigger consciousness of the emotional response and provide an initial justification based hippocampal call up of DA mediated, short term, memories of the suffering witnessed in association with the bomb. Nagai seeks gratification in the pointless action of kicking the spear. As Nagai apprehends the bamboo spear, DA floods the NAc in anticipation. *Globus pallidus* (GP) and the SN select patterns of cortical activity and motor programs for action, drawing on movement sequencers

[65] Ibid.

[66] Terminology popularised by Joseph LeDoux. Cf. Joseph E. LeDoux, *The Emotional Brain: The Mysterious Underpinnings of Emotional Life* (Phoenix Press, 1999).

in the *dorsal striatum*. The *hippocampus* is enlisted for goal direction. The BG instruct the motor areas of the PFC via the *BG-thalamo-cortical loop*. PFC and motor cortices deliver executive command. The bamboo is kicked. The BLA is now drawing input from widespread cortical areas, and from, and from cortical, hippocampal and striatal memory systems. Nagai shows a greater awareness of his current state, looking around and reflecting on his situation. Attempts to articulate the situation serve to mitigate his passionate reaction. Nagai indulges in a flight of imagination calling up a succession of cortical representations of future scenarios, and thereby diverts his attention away from sensory input and into deliberation. Effectively he is buying time for cortical processing of the overwhelming emotion. The initial surge of passion, corresponding to a neuromodulating flood of ACh and DA, dissipates somewhat and he is able to adopt a more cognitive response. His training in self-discipline can now take effect. Also he is conscious that he has an audience. His desires to give good example, despite an absence of evident reward, are mediated by overlearned *stimulus response* (S-R) responses in the ventral striatum. His prior training has established this mechanism that is now available to him.

d. "I read the leaflet once and was stunned."[67]

By learned pathways of reflection Nagai sets about the task of reaching the truth of the situation. Quickly Nagai refocuses on reaching the truth or falsehood of the American claim. He seeks to weigh the message of the leaflet with his own assessment. Prior to the commencement of his deliberative reading there is a moment of "election" towards the means to reach the chosen good: by reading and calm consideration he decides he will reach the truth. Despite the almost overwhelming emotion of the moment, he draws on learned neural pathways of determination with the goal of uncovering the truth no matter how unpalatable. He makes a judgement that the truth can be reached by suppressing immoderate emotion and then applies himself rereading the leaflet weighing its assertions against his own knowledge and estimations.

Nagai's self-mastery, established in a habitual way by prior learning, is characterised by obedience of the emotional realm to rational command. Goals and rewards are not needed as incentives. S-R processes give way to intentional *action-outcome* (A-O) learning. Input to the PFC via the *BG-thalamo-cortical loop* reestablishes higher cortical, as opposed to emotion driven, management. Emotional thalamic and limbic centres are now redisposed to cortical inhibition of impulsive response. Prior learning of fortitude and

[67] Nagai, *Bells,* 52.

temperance have established pathways moderating emotional responses, so they are obedient to rational direction; and these neural pathways are activated. The habit of fortitude will be present in preferential pathways in the *BG-thalamo-cortical loop* and strengthened top-down connections between the OFC and the amygdala. The prior habituation of temperance will be present in mediation primarily by the DLPFC and *anterior cingulated cortex* (ACC). In the past it is likely that this habituation was associated with DA rewards that consolidated the pathways of self-control. In this current scenario, with the habit established, it is unnecessary for DA perfusion to take place. Various brain regions now coordinate to regulate emotional reaction: OFC, DLPFC, VMPFC, further areas of the amygdala and of the BG. Emotional regulation leads to cortical direction of reward expectations. Emotional representations are consciously suppressed. Cortical management is consolidated via action plans involving rereading. Even though it is unlikely that this is a conscious strategy, nevertheless it is likely to be a learned strategy to divert oneself into a cognitive task in order to take the heat out of emotion.

e. "I read it a second time and felt they were making fools of us."[68]

Nagai's established dispositions to moderate and divert excessive emotional representations and expressions are the result of prior learning. The actions of these dispositions permit cortical deliberation to occupy his attention. Nagai's response in this situation, and his character in general, is built on previously established behaviours and convictions upon which he can draw.

Nagai's habit of application at the task until the desired outcome is achieved as a consequence of prior training. His election of the goal to read and reread involves deliberative evaluation utilising numerous cortical areas, drawing particularly on episodic memory, self-knowledge, scientific knowledge and skills of critical assessment.

Intrinsic motivations have come to the fore: of commitment to the truth, and that one's duty to others must be fulfilled. These appear to be the result of cortical neuronal pathways established and consolidated by prior experience and DA reinforcement, originating in the *ventral tegmental area* (VTA) and SN and mediated by the *ventral striatum*, by childhood and military training and in happier times. The prior habituation of prudence will be present in this rich and reciprocal connectivity, primarily to and from the DLPFC, with other cortical areas serving memory and somatic and sensory input, with the OFC, DMPFC, BG, and *amygdala* serving emotion regulation, with the *ventral striatum* assisting in goal setting and motivation. Similarly the prior habituation of justice consists of consolidated pathways in the

[68] Nagai, *Bells,* 52.

anterior and medial PFC, the VMPFC, OFC (especially medial OFC), ACC (especially *rostal ACC*), *insula*, *limbic and paralimbic areas*, and the BG. These rich connections serve to give preferential traffic to deliberations about understanding of others, consideration of the impact of one's actions on others, empathy, and considerations of fairness, etc. It is possible to detect in this change of behaviour the classic pattern noted by Graybiel; a passing from reward mediation in the *ventral striatum* (Nagai's kicking fruitlessly against the goad), associated with the emotional gratification, to a dorsal automatisation, carrying out duty as he has trained himself to do (Nagai's determination to grapple with the truth and face it).[69] Such an automatisation is consistent with our knowledge of the character of this wonderful man.

f. "I read it a third time and was enraged at their impudence."[70]

In neural terms Nagai is aware of cortical representations of attractive or aversive sense objects, and that reward systems provide neuromodulatory incentive for preferential attention to, and pursuit of these goals via appropriate action plans. Cognition and the capacity to reach the truth can be overwhelmed by the presentation of attractive or aversive cortical representations. This is the battle that Nagai fights in the first, second and third reading. However, by holding to his action plan of rereading he is able to regulate the emotion sufficiently to allow deliberation and a final judgement as to the truth of the American message. As we are discussing aversional content, direct involvement of reward systems is minimal. However, during prior learning the habits of prudence, justice, fortitude and temperance were established; during this time the reward systems were greatly active, leading to DA mediated reinforcement of regulatory pathways triggered in the OFC and *amygdala* by sense representations. These pathways are available now for Nagai's use in coping with this particularly difficult situation.

g. "But when I read it a fourth time I changed my mind and began to think it was reasonable."[71]

Nagai has reached the point of making a judgement about the trustworthiness of the American leaflet. Nagai's neural activity is likely to include heightened activation in numerous areas. The DLPFC, ACC, the ventral striatum, and amygdala will reveal principal activation. Above baseline activation will also be evident in medial PFC, VMPFC, OFC, the *posterior cingulate/retrosplenial cortex*, *superior*

[69] Ann M. Graybiel, "Habits, Rituals, and the Evaluative Brain," *Annual Review of Neuroscience* 31 (2008): 359-387.

[70] Nagai, *Bells,* 52.

[71] Ibid.

temporal cortex, STS, the *temporo-parietal junction*, *medial hypothalamus*, and insula. Left PFC and right OFC will be active in the suppression of sadness. Considerations of the social norms of patriotism and of cultural expectations of a leader will involve further integration of areas such as the VMPFC, lateral OFC, and the *anterior temporal lobes*, assisted by storage of social perceptual representations in the *temporal lobes*. In addition, reflecting Nagai's frustration at the shame of defeat and empathy with the pain of others, the *rostral ACC*, and the *anterior insula* will be active. The *posterior cingulate*, and *inferior parietal lobe* will show activity during the Nagai's brief catastrophising.

h. "But when I read it a fourth time I changed my mind and began to think it was reasonable. After reading it a fifth time I knew that this was not a propaganda stunt but the sober truth."[72]

He gives his assent to the assertion of the leaflet. His word "sober" indicates he has achieved mastery of impulsive response, in contrast with his fierce kick to the bamboo spear: destructive, impulsive, futile, and pointless. Acquiescence to the truth implies also a degree of self-mastery. Note the capacity of the brain to operate multiple processes, concurrently and in concert, in support of goals of the person's own choosing.

In Nagai's reading of the flyer, in this single human act seeking the truth of the issue, we have witnessed a highly complex interplay of systems (memory, emotional management, deliberation, goal election, consideration of consequences of action, moral judgement, attention, reward to some extent, and motor execution), brain areas, mechanisms, and pathways. Throughout he has drawn upon learned (prior) responses to emotion, and in this episode, he is able to further reinforce the neural pathways underpinning a virtuous response. The end result is the harmonisation of the emotional life with the rational life. The disorder of actions carried out without cognitive approval and direction, is replaced by a grasping of truth and a quieting of wayward passion. Virtue thus may be understood as supported at the neurobiological level by a harmonised complex of systems.

IV. Conclusion

A close examination of Nagai's response offers an augmented understanding of the neural bases of self-control within an anthropology supported by TMP. Within this view, virtue, as understood by Aristotle and Aquinas, is embodied, mediated by the neural structures, pathways and mechanisms. In this final section, I draw together some insights into human fulfillment and virtue suggested by this neurobiological study.

[72] Ibid.

Appreciation that character has a biological basis offers practical insights into the role of emotional management in development of character: we see the effects of this in Nagai's wrestle with motivation, and also in his final acquiescence. This exploration of Nagai's experience exposes the mechanisms whereby intentional management of emotion not only brings better immediate outcomes for the person, but also that, though use-induced plasticity, behaviours predispose for further emotional management. Nagai's experience serves to demonstrate that personal development lies in choosing the right goals for our actions: that repeated actions build a facility for future action, and that habits of emotional management may be established to support future action.

Emotional regulation is supported by limbic-cortical connectivity permitting bottom-up modification of cortical "decision making," and top-down direction and regulation. Neuroscience and philosophy converge in describing the complementary roles of emotion and reason in a balanced happy life. Given that neural pathways are plastic, strengthening with use, and falling into atrophy in disuse, the very presence of substantial reciprocal neural pathways is firm evidence of both cortical direction and subcortical modification of regulation and decision making. Similarly human motivation and goal election are supported by the reward structures of the brain that are in reciprocal communication with cortical structures.

We see that Nagai's cognitive activity founded in the PFC requires the complement of subcortical structures of the limbic system and the BG for effective emotion regulation and goal election. The involvement of the BG appears crucial, not only by its implication in emotion and reward pathways but also because the BG are the principal seat of automaticity of actions, which has ultimately assisted Nagai in bringing the tension to a conclusion. Such automaticity is not necessarily opposed to conscious, voluntary goal election.

Nagai's account draws attention to the very process of formation of the intentional self-control. Consistent with the weight of current neuroscientific opinion concerning the capacity for economies of interconnection in the brain, we are led to consider the state of a virtue as a complex of systems. Interdependent with processes of emotion regulation we find systems of responses to pleasure, pathways for fear responses, reward evaluation, goal setting, motivation and executive control, all supported by "upstream" systems of plasticity, learning and memory, and capacities for attention, critical learning, imitation, and empathy.

It is apparent, too, that self-management of emotion brings a liberating result evident in the acquiescence of Nagai. Our free and conscious efforts form, or reform, our very biophysical constitution into neural structures,

better capable of supporting effective self-management at the rational level. Hence the process is apparent whereby virtue is acquired, and freedom augmented.

In conclusion, it may be seen that virtue has a material foundation in the neural structures, systems and processes of the brain and that these material aspects can be identified. These neural structures manifest, in their maturity of expression and integration across the entire brain, the role that virtue plays in human fulfilment itself, and that there is a biological aptitude and *predisposition* in human beings for the development of virtue.

That the neurobiology of virtue may be described, and that it is associated with a state of neurobiological perfection, must carry far reaching implications for the study of ethics. Aristotle proclaimed, "Happiness is the reward of virtue," with happiness understood as human fulfilment, flourishing, *eudaimonia*.[73] Happiness, understood as flourishing, seems, to the most considerable extent, a consequence of the neurobiological presence of virtue.

References

Anscombe, Elizabeth. "Modern Moral Philosophy." In *Virtue Ethics*, edited by Roger Crisp and Michael Slote, 26-44. Oxford University Press, 1997.

Aquinas, Thomas. *De ente et essentia*. Edited by Joseph Kenny, O. P. https://isidore.co/aquinas/DeEnte&Essentia.htm.

Aquinas, Thomas. *De potencia Dei*. Edited by Joseph Kenny, O. P. https://isidore.co/aquinas/english/QDdePotentia.htm.

Aquinas, Thomas. *De substantiis separatis*. Edited by Joseph Kenny, O. P. https://isidore.co/aquinas/SubstSepar.htm.

Aquinas, Thomas. *Questiones disputatae de veritate*. Edited by Joseph Kenny, O. P. https://isidore.co/aquinas/QDdeVer.htm.

Aquinas, Thomas. *The Summa Contra Gentiles*. Edited by Joseph Kenny, O. P. Hanover House, 1955-57. https://isidore.co/aquinas/ContraGentiles.htm.

Aquinas, Thomas. *The Summa Theologica*. Translated by Fathers of the English Dominican Province. https://www.newadvent.org/summa/.

Aristotle. *The Complete Works of Aristotle: Volumes 1 and 2*. Edited by Jonathan Barnes. Princeton University Press, 1984.

Armstrong, D. M. "Mind-Body Problem: Philosophical Theories." In *The Oxford Companion to the Mind,* edited by Richard L. Gregory. Oxford University Press, 2006.

[73] Aristotle, *Nicomachean Ethics*, 1099b16.

Barnes, Gordon P. "The Paradoxes of Hylomorphism." *The Review of Metaphysics* 56, no. 3 (2003): 501-523.

Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. *Neuroscience. Exploring the Brain*. Lippincott Williams and Wilkins, 2007.

Carreño, Juan Eduardo. "From Self Movement to *Esse*: The Notion of Life and Living Being in Thomas Aquinas." *Angelicum* 92, no. 3 (2015): 347-376.

Clarke, William N., S. J. *Explorations in Metaphysics: Being-God-Person*. University of Notre Dame Press, 1994.

Clarke, William N., S. J. *The One and the Many: A Contemporary Thomistic Metaphysics*. University of Notre Dame Press, 2001.

Cullen, Christopher M., and Franklin T. Harkins, eds. *The Discovery of Being & Thomas Aquinas: Philosophical and Theological Perspectives*. Catholic University of America Press, 2019.

Fabro, Cornelio, and B. M. Bonansea. "The Intensive Hermeneutics of Thomistic Philosophy: The Notion of Participation." *Review of Metaphysics* 27, no. 3 (1974): 449-491.

Fabro, Cornelio. "Platonism, Neo-Platonism and Thomism: Convergencies and Divergencies." *The New Scholasticism* 44, no. 1 (1970): 69-100.

Fabro, Cornelio. "The Problem of Being and the Destiny of Man." *International Philosophical Quarterly* 1, no. 3 (1961): 407-436.

Fabro, Cornelio. *Esegesi Tomistica*. Libreria Editrice della Pontificia Università Lateranense, 1969.

Fabro, Cornelio. *La Nozione Metafisica di Partecipazione Secondo S. Tommaso d'Aquino*. Società editrice internazionale, 1950.

Fay, Thomas A. "Participation: The Transformation of Platonic and Neoplatonic Thought in the Metaphysics of Thomas Aquinas." *Divus Thomas* 76 (1973): 50-64.

Feser, Edward. *The Philosophy of Mind: A Short Introduction*. Oneworld Publications Limited, 2005.

Glynn, Paul. *A Song for Nagasaki*. Marist Fathers Books, 1988.

Graybiel, Ann M. "Habits, Rituals, and the Evaluative Brain." *Annual Review of Neuroscience* 31 (2008): 359-387.

Haldane, John. "A Return to Form in the Philosophy of Mind." *Ratio* 11, no. 3 (1998): 253-277.

Hankey, Wayne J. "Placing the Human: Establishing Reason by Its Participation in Divine Intellect for Boethius and Aquinas." *Res Philosophica* 95, no. 4 (2018): 583-615.

Jaworski, William. *Structure and the Metaphysics of Mind: How Hylomorphism Solves the Mind Body Problem*. Oxford University Press, 2016.

Kandel, Eric R., James Harris Schwartz, and Thomas Jessell. *Principles of Neural Science*. McGraw-Hill Companies, 2000.

Koslicki, Kathrin. *Form, Matter, Substance*. Oxford University Press, 2018.

Koterski, Joseph W. "The Doctrine of Participation in Thomistic Metaphysics." In *The Future of Thomism*, edited by D. Hudson and D. Moran, 185-196. University of Notre Dame, 1992.

LeDoux, Joseph E. *The Emotional Brain: The Mysterious Underpinnings of Emotional Life*. Phoenix Press, 1999.

Lycan, William G. "Is Property Dualism Better off than Substance Dualism?" *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 164, no. 2 (2013): 533-542.

Madden, James D. *Mind, Matter, and Nature: A Thomistic Proposal for the Philosophy of Mind.* The Catholic University of America Press, 2013.

Mitchell, Jason A. "Being and Participation: The Method and Structure of Metaphysical Reflection according to Cornelio Fabro." PhD diss., Pontifical Athenaeum Regina Apostolorum, 2012.

Mullins, Andrew P. J. "An Investigation into the Neural Substrates of Virtue to Determine the Key Place of Virtues in Human Moral Development." PhD diss., University of Notre Dame Australia, 2012.

Mullins, Andy. "Can Neuroscientific Studies Be of Personal Value?" *International Philosophy Quarterly* 57, no. 4 (2017): 429-451.

Mullins, Andy. "A Thomistic Metaphysics of Participation Accounts for Embodied Rationality." *International Philosophical Quarterly* 62, no. 1 (2022): 83-98.

Mullins, Andy. "Philosophical Prerequisites for a Discussion of the Neurobiology of Virtue." *Ethical Perspectives* 23, no. 4 (2016): 689-708.

Mullins, Andy. "Rationality and Human Fulfilment Clarified by a Thomistic Metaphysics of Participation." *Scientia et Fides* 10, no. 1 (2022a): 177-195.

Nagai, Takashi. *The Bells of Nagasaki*. Translated by William Johnston. Kodansha America Inc, 1994.

Nussbaum, Martha C., and Hilary Putnam. "Changing Aristotle's Mind." In *Essays on Aristotle's De Anima*, edited by Martha C. Nussbaum and Amélie Oksenberg Rorty, 27-56. Clarendon Press, 1995.

Squire, Larry, Darwin Berg, Floyd E. Bloom, Sascha du Lac, Anirvan Ghosh, and Nicholas C. Spitzer, eds. *Fundamental Neuroscience*. Elsevier, 2008.

Walker, Adrian J. "Personal Singularity and the *Communio Personarum*: A Creative Development of Thomas Aquinas' Doctrine of *Esse Commune*." *Communio* 31 (2004): 457-479.

Wippel, John F. *The Metaphysical Thought of Thomas Aquinas: From Finite Being to Uncreated Being*. The Catholic University of America Press, 2000.