

# *Relationality and Health: A Transversal Neurotheological Account*

with Pat Bennett, “Landscape Plotted and Pieced’: Exploring the Contours of Engagement between (Neuro)science and Theology”; Pat Bennett, “Things Counter, Original, Spare, Strange’: Developing a Postfoundational Transversal Model for Science/Religion Dialogue”; and Pat Bennett, “All Trádes, Their Gear and Tackle and Trim’: Theology, Cognitive Neuroscience, and Psychoneuroimmunology in Transversal Dialogue.”

## “ALL TRÁDES, THEIR GEAR AND TACKLE AND TRIM”: THEOLOGY, COGNITIVE NEUROSCIENCE, AND PSYCHONEUROIMMUNOLOGY IN TRANSVERSAL DIALOGUE

*by Pat Bennett*

*Abstract.* This third of three articles outlining a different approach to science/religion dialogue generally and to engagement between theology and the neurosciences specifically, gives a brief account of the model in practice. It begins by introducing the question to be investigated—whether the experience of relational connection can affect health outcomes by directly moderating immune function. Then, employing the same threefold heuristic of encounter, exchange, and expression used previously, it discusses how the transversal model set out in these articles has been used to investigate this question and to develop a theoretical physiological model for the proposed link between relationality and health.

*Keywords:* cognitive neuroscience; Gabriel Marcel; neurotheology; psychoneuroimmunology; relational connection; transversal space dialogue; Trinitarian theology; J. Wentzel van Huyssteen; Hans Urs von Balthasar

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*Glory be to God for dappled things –  
And all trádes, their gear and tackle and trim.*

Gerard Manley Hopkins

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In the first of this set of articles (Bennett 2019a), I explored some of the persistent tensions underlying the science/religion dialogue,<sup>1</sup> looking particularly at how these affect attempts to develop a coherent interaction between theology and the neurosciences. I then discussed the neurotheological approaches adopted by James Ashbrook and Andrew Newberg, arguing that these foundered in part due to the absence of a robust methodology for negotiating the dialogical difficulties noted. In the second article (Bennett 2019b), I looked at the underlying philosophical bases and key dynamics of the transversal space dialogical model developed by J. Wentzel van Huyssteen. Building on these I proposed an extension to van Huyssteen's model to facilitate a different type of dialogical outcome, suggesting that such a model could provide the basis for a very different approach to neurotheology, one moreover with the potential for producing a genuine expansion of knowledge as a result. This final article of the set demonstrates how the methodology was used to explore a particular point of intersecting interest between theology and neuroscience, *viz.* the link between relational connection and health (Bennett 2013). After briefly introducing and outlining the area to be explored, I will again use the framing of encounter, exchange, and expression to demonstrate how the model was used to enable the identification of both fruitful points at which to develop transversal spaces and of suitable contributing voices to these; and how the "transversal outputs" from the resulting conversations were put together in different ways to build a composite argument in response to the questions under exploration. The article will conclude with a brief description of the resulting theoretical model and a discussion of whether and in what ways the neurotheological approach used in its generation addresses some of the problems and answers some of the criticisms raised in both of the earlier articles.

#### THE LINK BETWEEN SOCIAL CONNECTION AND HEALTH: A SUITABLE CASE FOR NEUROTHEOLOGICAL EXPLORATION?

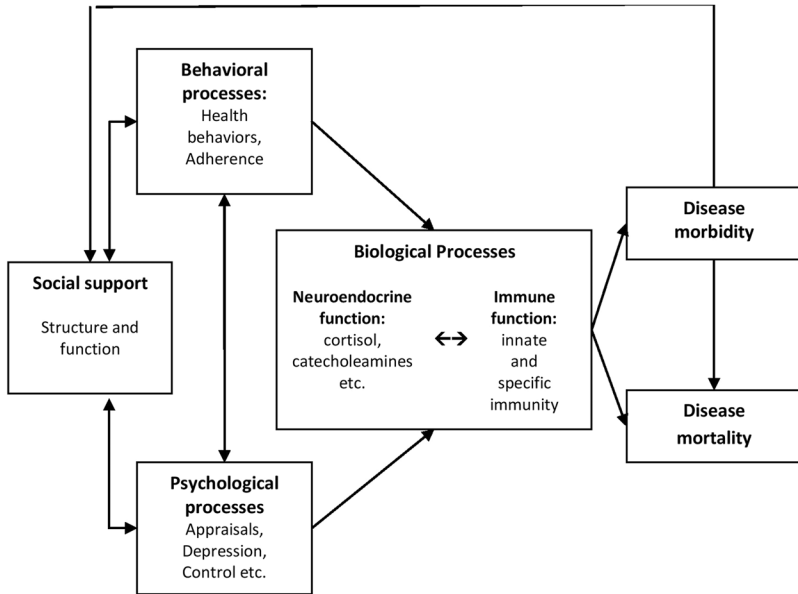
The long-noted link between aspects of social status and health outcomes (Graunt [1662]1939) has been extensively investigated by epidemiologists, most recently through long-term prospective studies of community populations. Such studies have consistently and reliably demonstrated a correlation between social support and levels of morbidity and mortality: social connections that are either numerically or experientially impoverished are significantly linked to increased mortality from almost all major disease groups (for meta reviews of major studies see Berkman 1995, 245–54; Cohen 1988, 269–97; House et al. 1988, 540–45) at a level comparable with other well-established mortality risk factors (Holt-Lunstad et al. 2010, 12). In a seminal article, James House and his colleagues judged that there were reasonable grounds to conclude that social relationships

had a predictive, and arguably causal, relationship with health *in their own right* (House et al. 1988, 545). Further studies have followed and there is now a substantial volume of literature exploring and establishing this link and investigating a wide range of outcomes related to it.

Connections between social factors and disease have also been extensively studied within the emerging discipline of psychoneuroimmunology (hereafter PNI), which explores the relationships between behavioral, neural, endocrine, and immune processes. It is now well established that the immune system is hardwired to the central nervous system, with bidirectional communication and influence (Irwin 2008, 137) via endocrine hormones and cytokines. The latter are a diverse group of small proteins, which act as the basic signaling molecules of the system. They have complex regulatory feedback loop systems and are intimately involved in inflammatory processes (as both pro- and anti-inflammatory agents). Since such processes are increasingly understood as playing a key role in disease etiology, the balance between these two aspects of cytokine activity is critical, with dysregulation potentially an important factor in health outcomes. As with the epidemiological work cited, correlation does not prove causality; however, large-scale reviews (e.g., Uchino 2006, 377–87) of the wide range of studies looking at various components of PNI function in relation to social support networks have once again demonstrated social support to be reliably related to a variety of beneficial effects on the cardiovascular, endocrine, and immune systems.

Bert Uchino and colleagues (Uchino 2006, 378; Uchino et al. 2012, 220) have developed a broad theoretical model highlighting the routes by which social support might influence physical health outcomes. This postulates two distinct pathways: the first behavioral, the second a psychological one involving appraisals, emotions, moods, feelings of control, and so on. Each is thought to be influenced, in different ways, by the structural and functional aspects of social support, and also to act on each other; and both are deemed to exert their ultimate effects on morbidity and mortality through the common broad biological pathway of the intimately and reciprocally linked endocrine and immune systems. Figure 1 gives a simple visualization of this complex web of multidirectional influence and effect.

Two additional aspects not represented in this model but which are germane to the current project should also be noted. First is the *location* of the main protective effect—that is, whether support works primarily by ameliorating stress/raising the threshold at which given events are perceived as stressful (thus reducing the initial extent of excitation of physiological responses from without)—a likely mechanism where richer social support promotes greater access to information and services and so on; or whether the functional response of endocrine and immune systems to central nervous system excitation are directly moderated in some way by the experience of social connection (thus altering response from within).



**Figure 1.** Potential pathways by which social support may influence physical health outcomes (after Uchino et al. 2012, 220).

Second is the *timing* of the protective effect, that is, whether moderation occurs primarily in direct connection with stressful events themselves (the “stress-buffering” model), or whether it occurs independently of the level of stress (the “main effect” model).

However, both epidemiological and PNI studies suggest that there may be something additional going on, which is not accounted for by Uchino’s two routes and this raises the possibility that a more direct physiological pathway connecting social experience and health might be operating—*viz.* that the *actual experience of relational connection itself* might directly affect immune function. If this were the case then it would constitute an additional pathway to Uchino’s basic model connecting “social support” directly to “biological processes” without routing it through either the “behavioral” or “psychological” staging posts. One possible hypothesis here given the evidence at hand from PNI studies would be that relationality<sup>2</sup> is an emergent phenomenon arising from a complex system supporting social signal surveillance, decoding, and response, and can thus exert direct causal influence on components of that system, including its endocrine and immune signaling elements, with consequent health effects downstream. However, given the complexity of PNI systems and the many and varied methodological challenges associated with studying these (e.g., controlling for a large number of potential confounding variables; standardization of

collection and measurement; the gap between *in vitro* measurement at cellular level and *in vivo* function at systems level; potential discrepancies between statistics and clinical significance in readings, and so on), this is not necessarily something that can be investigated solely from within the discipline. As such it falls into one of the categories which I earlier suggested were suitable for transversal neurotheological explorations (Bennett 2019a).

The questions therefore are, first whether and how theology, PNI, and cognitive neuroscience—with their distinctively different “gear and tackle and trim”—can be brought into the kind of transversal space dialogue envisaged by van Huyssteen to explore this possibility; and second whether this could then generate the kind of composite transversal arguments and evidence outlined in the second article as part of an extension of this model (Bennett 2019b). I will use the three headings suggested earlier as a way of exploring how the proposed methodology and the underlying dynamics of postfoundational rationality enable negotiation of some of the difficulties outlined in the initial article (Bennett 2019a) and the generation of a genuinely “neurotheologically informed” and coherent account of a potential pathway linking social connection, immune function, and health outcomes.

#### ENCOUNTER: IDENTIFYING A SUITABLE LOCUS

In the first article I suggested that one of the key challenges facing any attempt to produce a coherent approach to neurotheology is to locate suitable places at which nonreductive interactions between theology and the neurosciences can be set up. This is a key element of van Huyssteen’s model and his transversal reasoning strategy—a ranging over the different constellations of thought and action, which makes up our situated experiences in order to identify points of consensus, which might be usefully brought into conversation—provides a mechanism for identifying such places.

The starting point of the proposed project was thus, in keeping with the transversal methodology laid out in the previous article (Bennett 2019b), to establish that there was a sufficiently strong point of intersection between theological and neuroscientific perspectives to suggest that the links between relationality and health suggested by epidemiological studies could be usefully illuminated by a neurotheological exploration. The PNI interest in the connection has already been indicated but studies thus far have mainly identified the links rather than elucidating their underlying mechanisms—something that has been seen as the primary research objective for “second-wave” PNI studies (Uchino et al. 2012, 220). From the theological perspective a strong connection between relationships (i.e., human/divine, human/human, human/creation), well-being, and human flourishing is a major element of themes and motifs woven throughout the

Biblical canon. Indeed relational connection and the consequences of its disruption lie at the heart of both Old and New Testaments. There is thus clear evidence of two intersecting disciplinary lines here—and hence the possibility of the formation of one of van Huyssteen’s transversal spaces where discussion and exchange predicated on and answerable to the epistemic standards of postfoundational rationality can be set up.

The next step was to discern whether within this initial transversal space there might be other intersecting lines, which would allow the exploration of the hypothesis to be broken down into three discrete and distinctly different areas—relationality as basic to humanness; relationality as an emergent phenomenon; and relationality as a realized experience. Here again transversal reasoning skills proved a useful tool in allowing sometimes unlikely areas of potential intersection to be identified. In the case of the first scenario, the understanding that humans are social creatures is hardly novel but there has been an increasing interest in the social nature of humankind across a variety of academic spheres. In the biological sciences, this has seen the emergence of social neuroscience with its explorations of the neural underpinnings of social behavior and the pathways for social signal decoding. In theology it has stimulated a resurgence of interest in social understandings of the Trinity and the significance of these for our understandings of human connection and well-being (e.g., Swinton 2000). Thus here too there was a clearly identifiable area of overlapping interest between theology and (this time) cognitive neuroscience in exploring the nature and enabling of relational connection in human persons.

If we looked to the second area—relationality as emergent—the ground chosen for dialogical connection was somewhat different. Here the neurotheological exploration envisaged was of whether relationality might be a candidate for construal as an emergent phenomenon arising from neurobiological systems dealing with social signal decoding. However, at first sight there is not an immediately obvious point of intersection between theology and cognitive neuroscience here. Moreover, the aim was not for a theological contribution in the form of an inversely applied *analogia entis* as a means of “validating” emergence as a genuine phenomenon, but rather to see where theology might contribute something from its own very different wisdom to exploring the question in hand. One of the beauties of van Huyssteen’s model is that, in shifting the locus of disciplinary parity away from critical realism, it allows a much more imaginative approach to finding areas for potential dialogue. In this instance the different disciplines came into conversation by each providing input on one of three critical aspects of emergence—complexity, restraint, and top-down causality. These contributions were also located at different levels of operation: in the case of cognitive neuroscience from that of neural architecture and neural nets; from PNI at the level of cellular function; and from theology at the cognitive level, something I will discuss further below under “exchange.” In the

final instance there was once again a more straightforward locus of interaction identifiable, with both theology and PNI having an interest in the effects of different types of relational interaction on human flourishing. In the case of the latter, this concerns a corpus of experimental studies looking at variations in different immune markers in connection with different interactional styles. In that of the former, this concern is a part of theology's wider interests in human relational experience, in particular how different dispositions toward relational connection affect its shaping and expression.

From all these perspectives, then, there were indications of sufficient intersecting points of interest between theology and various different branches of neuroscience to warrant an attempt at setting up a variety of transversal space dialogues as part of a neurotheological exploration of links between relationality and health. The model's inherent dynamics also allowed a further refinement of intersecting points within these different arenas—something I will discuss further in the next section.

However, the identification of suitable loci for dialogue is only the first element of the epistemic responsibility the proposed methodology entails. As discussed previously (Bennett 2019b), successful transversal interactions also require close attention to the selection of contributing material and a critical evaluation of various aspects of this in keeping with the model's postfoundational commitments. Once again the dynamics inherent in van Huyssteen's formulation of postfoundational rationality provide the mechanisms for this predialogical winnowing.

#### EXCHANGE: TRANSVERSAL SPACE RESPONSIBILITIES AND DYNAMICS IN ACTION

Van Huyssteen's shift of the locus of interdisciplinary connection from the *specific methodological* to the *shared rational* simultaneously moves the standards of accountability from the *domain-specific* to those that are inherent *in rationality itself*. This has important consequences for the "epistemic contract" under which any resulting transversal space dialogue (including those of the proposed extension) operates, since both processes and proposed dialogical outcomes must now be answerable to the standards of postfoundational rationality set out in the previous article (Bennett 2019b). Thus setting up transversal dialogues between theology and neuroscience requires that any material put forward as a contribution to such exchanges must be open to critical evaluation from the other contributing disciplines—there can be no privileged material or appeal to "special status" for either theology or science.

For the neurotheological project under discussion this involved a number of key operations as a preliminary to each of the three transversal exchanges outlined above. For the different theological contributions to the project, this took the form in each case of a critical analysis of how each had been

developed as a way of demonstrating two key things: first that this was consonant with the employment of postfoundational rationality; second that there was no covert appeal to privileged texts. The aim here was to select theological insights that are transferable, that is, which have a validity and utility *beyond* the specific issues, theologoumena, and frameworks that have generated them, and which thus also do not necessitate a concomitant assent to religious propositions—something that can keep science/religion dialogue confined to various apologetic cul-de-sacs. At the same time it was necessary to also ensure that the ideas were properly engaged with and not eviscerated of that which made them distinctively theological (cf. Westhelle 2000, 171).

Thus, for example, the theological contribution to the first transversal engagement came from the fourth century Cappadocian Fathers and their explorations—developed as part of an evolving understanding of the Trinity—of the nature of personhood and the role of relational connection in this. At first sight this seems unlikely to meet the criteria outlined above regarding something separable from particular religious doctrines. However, these particular ideas can be clearly traced as evolving in the response to critical challenges of prevailing understandings—one of the hallmarks of rationality in action. Moreover although the starting point for the explorations of the Cappadocia Fathers was a very particular theological one, the resulting insights fundamentally changed the concept and status of personhood. Hence, although the starting point was a peculiarly theological concern with little traction itself in terms of the science/religion dialogue envisaged here, one of the results was a changed but rationally defensible understanding of human personhood, which *was* transferable beyond the subject matter of its theological origins and thus became a suitable contribution to offer to transversal engagement.

The theological voice selected for the second dialogue was that of Hans Urs von Balthasar. One of the most prolific, creative, and wide-ranging theologians of the twentieth century, the underlying attitudes that drive his theological project and the way in which he then executes it and presents his results fit very comfortably with van Huyssteen's template for a theological engagement directed by postfoundational rationality. Von Balthasar's sustained openness to the world and to its rich cultural heritages results in a hugely wide-ranging, thick, and eclectic theology, and the way in which he ranges over these sources, drawing out connections and knitting together disparate material, is strikingly reminiscent of Calvin Schrag's description of transversal rationality in operation (Schrag 1994, 66–70).

Similarly, and yet in a different way, the work of Gabriel Marcel, which formed the theological voice in the final conversation, also fits very comfortably within the dynamics of postfoundational rationality in action. In Marcel's case the participation, which is at the heart of his thinking and the very clear and creative ways in which he is able to open up some reflective



distance on this without reductively analyzing it and thus distorting or destroying key elements, are a striking exemplar of the participation and distancing of paraxial critique. Marcel uses his writing and particularly his plays to allow the narratee/audience (and himself) to simultaneously distance themselves from their own particular situated experience and yet, through being presented with material within which they can find points of identification and intersection, to reflect on these in a nonreductive participative way.

Both of these choices also testify to something that is one of the major creative strengths and chief pleasures of van Huyssteen's approach—namely, the way in which its shifts of locus and epistemic accountability open up the range of theological voices, which can now contribute to science/religion dialogue. Even more potent is the way in which it enables the use of very specific theological insights. Thus, for example, von Balthasar's work has no obvious intersection with emergence *per se*. However, his explorations of the nature of divine and human freedom in the second volume of the *Theo-Drama* (von Balthasar 1990), and of what this then reveals about the relationship between freedom, its restraint, and their connection with what is "other," provides a vital contribution to a dialogue exploring the dynamics of human relationality and whether it displays the cardinal signs of an emergent phenomenon. Similarly Marcel, writing long before the neuroscience with which he comes into conversation, identifies and provides a way for us to address the conundrum of how to critically investigate something when our own ontological status becomes part of the issue being explored, and we thus are ourselves part of the data under consideration. In such a scenario there is always the possibility—as noted in the reflections on ontological disjunction in the first article (Bennett 2019a)—that elements of the knowledge that we seek to understand and articulate may simply slip through our fingers. Hence Marcel proves a particularly useful partner to PNI in an exploration of the actual embodied experiences and effects of "good" and "bad" relational connection.

For the scientific contributions to the transversal conversations critical analysis was also the first move. Science just as much as theology can also employ appeals to privileged status—in this case that of the scientific method—as a means of deflecting criticism or avoiding engagement, and for nonscientists there are particular dangers in challenging received scientific wisdom. However, van Huyssteen's dialogical model demands that all contributing voices open themselves up to critical scrutiny as a prerequisite to transversal engagement, and thus for the scientific contributions a similar level of critical evaluation was employed. Here the specific aspects examined and critiqued depended on the particular experimental data being used. Many of the studies drawn on, particularly in the first of the transversal exchanges, were ones using neuroimaging. But while descriptions and images of brains "lighting up" may be epistemically

compelling—inviting us to believe (Roskies 2010, 214)—the reality of such scans is infinitely more complex. Thus much of the critical reflection on the science appropriated for this conversation was directed toward examining aspects of the nature and limitations of dynamic brain scans in three broad areas: process complexity, data interpretation, and experimental limitations. Brain processes are hugely complex involving feed-forward and feedback loops between different regions, with outputs reflecting the balance between excitatory and inhibitory influences. However, dynamic scans only measure levels of activity—they cannot provide any information on whether this reflects inhibitory or excitatory neuronal firing. This, combined with other things such as the pluripotency of brain regions, means that “activation maps” produced by scans do not necessarily yield information on how neural activity in a particular region is involved in the task in hand. There are also the inevitable and perennial issues around data selection and interpretation—especially given the way in which functional magnetic resonance imaging (fMRI) scans actually work; as well as questions about the extent to which experimental situations actually reproduce the type of cognitive processing that goes on in normal conditions, particularly given the physical limitations which dynamic scanning imposes on the subjects and thus the sorts of tasks that can be undertaken.

The aim with all of these reflections was not to undermine or dismiss the science but to avoid the uncritical acceptance and appropriation which has sometimes been a feature of science/religion dialogue. Properly understanding the strengths and limitations of the experimental data and thus what can be legitimately inferred from them was an important part of the move to build the “transversal” composite neurotheological arguments and understandings which the project was exploring. A similarly critical approach was taken with the PNI data, which were drawn on as part of the transversal exchanges. Some of the methodological challenges of PNI studies have already been noted above but other aspects were also considered—for example, the small number of studies and the small size involved in many of them, along with the lack of study repeats. Another issue of note here (and also to some extent in some of the cognitive studies)—especially in light of the observations on how community embeddedness shapes our investigatory choices and research strategies made in the previous article (Bennett 2019b)—is the very small number of research communities conducting these specialized studies, many of which are thus coming from the same group of authors. More specific aspects were also explored in connection with the studies of immune and endocrine function in the context of marital and long-term relationships used in the third transversal exchange, for example, whether factors other than relational discord were active but unperceived influences on commonly measured variables such as cardiovascular reactivity.

Finally, for both cognitive neuroscience and PNI studies there was the issue of extrapolating from measurements at cellular level to higher levels of organism function. Thus, dynamic brain scans essentially measure levels of oxygen uptake at neuronal level but results are typically expressed in terms of cognitive function. Similarly, some PNI studies extrapolate actual health outcomes from surrogate endpoints such as blood pressure or biomarkers. In both instances questions may be raised about either the legitimacy or the accuracy of such bridging maneuvers. However, this is one of the areas in which the kind of extended transversal dialogical model proposed in the previous article (Bennett 2019b) might prove a useful tool—and it is the consideration of conversational outcomes to which this article now turns.

#### EXPRESSION: ARTICULATING DISTINCTIVE NEUROTHEOLOGICAL ACCOUNTS

In this section, I want to look at two different aspects of the expression phase of dialogue: first, how material from each of the three dialogical interactions described was put together to form the composite contributions envisaged as part of the extension to van Huyssteen's model proposed in the previous article (Bennett 2019b); and second, outlining the final argument and model arising from these and looking at whether and how it addresses the criticism of other neurotheological approaches, which I offered in the first article of this set (Bennett 2019a).

To recap thus far, the transversal neurotheological exploration of the links between relationality, immunological function, and health outlined here was carried out through three different transversal engagements between theology and neuroscience (here in the form of cognitive neuroscience and PNI). Each of these represented a different step in the process of developing a neurotheologically informed argument that relationality was an emergent phenomenon arising from a complex system—developed and conserved through evolution—supporting social system decoding and response. Each transversal space was developed at a different locus of intersection between theology and neuroscience and each thus had different contributory materials. In a further testament to the rich flexibility that the model brings to dialogue, the materials were brought together in different ways to form the transversal outputs, which were then fed into the evolving argument. Here the guiding model was again that of Susan Haack's crossword analogy described in the second article (Haack [1993]2009, 126ff).

The first transversal encounter considered the issue of whether relationality is ontologically basic to humanness. The neuroscientific contribution came from a whole raft of studies exploring neural mechanisms for decoding social signals and the activity of mirror neuron systems—both of which are seen as providing evidence for the existence of innately

specified biological bases for social interaction. Some of the caveats about these studies have already been noted, to which should also be added ones relating to whether inferences from mirror neuron studies (despite their huge intuitive appeal) have been overextended into areas for which there is as yet insufficient warranting evidence. Theological material provided by a combination of the Cappadocian understandings of personhood and a rereading of the *imago Dei* in the light of this was similarly considered to be suggestive rather than conclusive. There were thus weaknesses and missing elements in the case offered by both disciplinary voices for considering relationally as an intrinsic element of humanness. However, the two were seen as offering (rationally defensible) mutual support for each other in a way which—drawing on Haack’s crossword analogy—enabled an affirmative answer to the question to be penciled in despite some missing letters.

In the second of the transversal space dialogues, the issue under consideration was whether the human capacity for developing and sustaining relational connection is more than simply the sum of the assorted neurobiological decoding processes that support it, and represents instead an emergent phenomenon. Here, as intimated earlier, the basis of the conversational contributions from the different disciplinary voices was somewhat different. To advance the case for designating relationality as an emergent property necessitates demonstrating that it exhibits key characteristics of these, something difficult to do (for various reasons) from within any single discipline here. Hence the transversal dialogue in this instance involved arguing the evidence for each of three cardinal features from the perspective of one of the project’s three contributory voices. Thus the presence of complexity, self-organization, and irreducibility to parts was considered through analysis of experimental data and structural studies from cognitive neuroscience itself; the presence of constraint as a necessary element of relational connection was argued from a theological perspective using the work of von Balthasar; and finally evidence for the operation of downward causation affecting system components was offered through data drawn from PNI studies. An important aspect here was that while the scientific contributions offered evidence located at the cellular level, the theological one examined the issue and discussed evidence at cognitive level. Since this is where the conscious, embodied experience of relational connection is located, there is a strong case that evidence for designating relationality as emergent must also be sought at this level. Thus while no one discipline could provide unequivocal evidence for all three of the designated hallmark features of emergence, each was able to furnish evidence for one of them, with the resulting strands then being integrated to form a transversal proof for the emergent nature of relationality. From an evolutionary perspective, this account of the incorporation of disparate elements of social decoding into a complex system also makes sense: for

an agent to survive, it must be able to detect and use regularities in its environment, and the more successfully it can build and maintain a maximally predictive internal model for these regularities, the greater its chances of so doing. Thus anything that increases the resources and expands the “language” for modeling improves the models, which can be made of different aspects of the environment—which in the social context is essentially a stochastic dynamical system consisting of other agents. Improving the coarse-graining capabilities of various signal decoding processes by connecting them together enables more complex modeling and maximizes the ability to respond appropriately, thus enhancing the chances of survival.

In the final transversal space engagement the area under exploration was the “feel” and effects of relationality as it is actually realized in everyday existence. Here the neuroscientific contribution came from a corpus of PNI studies looking at alterations in various immune markers in connection with different styles of relational interaction in partners. These particular studies, although relatively small in number, are seen as providing some of the most compelling evidence to date of social influence on immune functioning (Robles and Kane 2012, 205) and allowed a number of observations to be offered to the transversal synthesis from the PNI perspective: first, that aspects of how relational connection is realized appear to have direct immunological and endocrine sequelae; second, that these play out to two distinct time-scales with different short- and long-term consequences. Thus while more negative forms of relational expression have short-term effects that appear to convey some health advantages in terms of immediate response to invasion or insult, in the long term they appear to have adverse consequences from the perspective of health maintenance—something which will be important in the final model developed.

Set alongside this was the theological contribution drawn from the work of Gabriel Marcel. The dilemma posed by trying to investigate our relational connections with the Other solely through reductionist interpretations based on empirical data—*viz.* that it ignores that we ourselves included in the data set under investigation in a very particular way—has already been noted. Marcel—using both the description of experience and the reflective clarification of Mystery to enable a more expansive exploration of the dimensions of human experience (Hanley 1995, 132)—has evolved his own particular way of escaping this distortion. He thus brings a number of important contributions to the transversal exchange: first, a confirmation and reflection back of the challenge, which the scientific analyses already face regarding explanations of why the “feel” of relationality is important in ways that do not immediately seem to be simply functional. Second, through his particular and creative approach to participation, distancing, and reflection, Marcel offers a different way of exploring variations in *how* relationality might be expressed and experienced at the cognitive level.

In particular his thinking on *disponibilité* (“availability” would perhaps be the nearest English equivalent though this fails to do justice to Marcel’s rich concept) and creative fidelity, though very different from analysis at synaptic or hormonal levels, forms a vital adjunct to these in expanding our understanding of relational ontology and thus of its potential connection to health. Once again, then, the way in which the theological and neuroscientific contributions are brought together takes a completely different form from those in the other transversal space interactions. In this instance theology and PNI provide a perspective on the same issue but at different levels of operation, which are then conjoined to provide complementary facets of understanding a complex whole. In effect they operate like the obverse and reverse of a coin, with each side bearing different information, but each necessary to complete the whole.

What we have, then, are three different types of transversal space exchange, each bringing together theological and neuroscientific perspectives in different ways to form composite understandings and arguments, which belong neither to science nor to theology but instead can be designated as transversal, that is, existing in a space between the disciplines and answerable not to their domain-specific epistemic criteria but to those that inhere in postfoundational rationality itself. These three different transversal outputs can in their turn be put together in an interlocking way to posit the thesis that relationality is an emergent phenomenon arising from a complex system involved in social signal decoding and response. As such it therefore has the capacity—through the whole-part restraint mechanisms (i.e., top-down causation) characteristic of complex systems and their emergent phenomena—to influence the diverse cognitive, endocrine, and immune components of this system in ways which increase its predictive power, and thus the effectiveness of its response to different social scenarios—something with obvious associated survival advantages. However, the differing experiential possibilities of relational connection mean that the form and operation of such constraints may sometimes have consequences that are not beneficial to overall system functioning, and which may eventually lead to downstream health-related effects. Thus it would be a strong candidate for the “additional something” suggested by studies and not covered by Uchino’s two suggested routes of connection set out in Figure 1.

A final stage was thus to see whether a coherent, neurotheologically informed model could be developed on the basis of this proposed connection between relational experience and health outcomes. It is beyond the limits of this particular article to give anything other than a brief delineation of the main features and suggested physiological dynamics of this here, showing how these too draw further on elements of the transversal dialogues outlined above. First, though, it is necessary to sketch out the wider context of allostatic organism maintenance and repair in the face of

stress and some basic principles of how this is regulated, since these form the basic physiological system within which any such model must be set.

RELATIONALITY AND HEALTH: DEVELOPING A  
NEUROTHEOLOGICALLY INFORMED MODEL OF A POSSIBLE  
CONNECTION

Stress is known to be a potent moderator of immune and endocrine function; however, there is an inherent paradox in the simultaneity of its adaptive nature and the possible maladaptive consequences of this. A firefighting analogy is helpful to understand this: while water is necessary to extinguish some fires, overuse can lead to more damage than the original flames; furthermore increased usage can lead to a drop of pressure in the supply system with the consequent decline in effectiveness then contributing to the spread of flames. In the same way, stress responses are necessary—indeed they are a central part of allostatic maintenance and ideally are beneficial—but they can also come at a cost to the body, especially if elicited too frequently, or managed inefficiently (Korte et al. 2005, 4–5).

For an organism to survive, it needs to be able to maintain its internal environment within certain ranges. Since the body does not store vast reserves of essential materials, efficient response turns on reciprocal trade-offs, which enable resources to be directed where most needed in response to dynamic situations. Effective allocation depends on accurate prediction of what resources are likely to be needed as a given situation arises; this in turn necessitates that any relevant system sensors are able to adapt their sensitivity to the expected range of input, and any relevant response effectors to adapt output to the expected range of demand. Hence system sensors are a vital lynchpin in maintaining allostatic balance. Typically their transduction curves are sigmoid in shape with events most likely to occur matched to their greatest sensitivity and precision. By detecting fluctuating environmental signals, sampling signal strength and calculating a new probability distribution, sensors adapt to keep the curves centered on the most probable loads—a Bayesian adaptation seen at all levels of biological organization and drawing on a combination of sense data and prior experience to produce a best estimate of what is happening (Sterling 2004, 30).

Since all change involves a physiological cost, a critical element—and one that is vital to understanding the workings of the proposed model—is therefore the ability of sensors and effectors to adapt their sensitivity to the expected range of inputs so that response is not triggered either unnecessarily or too slowly, and that it is sufficient to meet the challenge but not excessive to the point of causing problems itself. Previous experience and higher cognitive functions play an important contributory role here—a point that is also germane to the proposed model.

Effectors must also adapt to meet predicted changes of demand, but the higher cost involved means that this tends to happen more slowly. Internal cellular activities are adjusted to facilitate manufacture of required products, but also (and importantly) there is alteration of both sensitivity and numbers of surface receptors in line with predicted demand over a spread of possible timescales. Thus prolonged exposure of an effector to high levels of its specific signaling molecule leads to a reduction in both the number and the sensitivity of its surface receptors (Sterling 2004, 33). In other words the responsive arm of the particular physiological pathway learns that the baseline circulating level of its signaler is now set higher and adjusts accordingly so as not to waste resources producing unnecessarily in response to this. Again this is an important factor in the context of possible pathological dysregulation resulting from poor relational quality.

Physiological regulation also receives vital input from high level cognitive mechanisms such as perception, memory retrieval, planning, emotions, and so on. Information from sensory systems is relayed to and decoded in dedicated cortical locations and extracted information is eventually collated via the prefrontal cortex with retrieved information from past experience. Emotional components such as anxiety, fear, or satisfaction—many receiving input from social signal decoding mechanisms—are added, and a best estimate about the situation under consideration is made (usually below the level of conscious cognition) and appropriate action initiated at the relevant level. Generally speaking, behaviors regulating physiological mechanisms tend to be rooted in either the drive to reduce anxiety or the desire to increase reward (Sterling 2004, 35–38).

Allostasis is thus essentially the fundamental process integrating physiology and behavior through which organisms actively adjust to both predictable and unpredictable events in their environment, and cytokines are among the primary mediators of the system. Any active response to change must of necessity result in a temporary imbalance of the primary mediators, because of stimulated production of some and relative suppression of others consequent on resource allocation. Such states can be maintained for limited periods provided energy input is adequate. However, if for some reason the imbalance continues then allostatic load—that is, the cumulative cost to the body of adjusting physiology/morphology/behavior to environmental change—rises. If the situation becomes chronic, allostatic overload can lead to pathophysiological changes with eventual health consequences.

As already noted, a key element of allostatic maintenance processes is successful predictive ability, something which depends in part on accessing, at cellular, system, and cognitive levels, previous experience of encountered states and situations. It is here, as part of the predictive element of the cycle, that the neurotheologically postulated connection between relational experience and health outcomes via downward causation might well be exerting its effects. The predictive environmental modeling made possible



by a complex system integrating social decoding and response has already been noted and could conceivably intersect with allostatic predictive mechanisms at the level of receptors, contributing information as part of sensor adaptation to keep detection curves centered on the most probable load in a given situation. In such a scenario it becomes possible to see how effects on immune and endocrine responses might be directly influenced by the shape of realized relational experience: if this is poor, then predictive modeling is likely to increase sensor threshold sensitivity so that allostatic responses are triggered at lower levels of social stress (since interpretation as potential threat is more likely) than in those who have less threat-sensitive comparative models. Similarly, effector thresholds may be altered to enable quicker and greater responses to perceived threat as a way of ensuring that maximum resources for adaptive or avoidance behavior can be accessed and maintained for as long as possible. From the neuroscientific perspective, additional supporting evidence for this can arguably be adduced from both PNI and cognitive neuroscience studies (e.g., Burklund et al. 2007, 238–53; Hackett et al. 2012, 1801–09; Masten et al. 2012, 106–14). From a theological perspective Marcel's insights into the extent to which we encounter (or do not encounter) *disponibilité* in those with whom we routinely engage would also lend support to the contention. Thus theological, cognitive, and PNI perspectives all suggest that how we encounter others in our day-to-day living has a significant effect on how we set the basic relational schemas, which then feed into different aspects of physiological function connected with social signaling and response: the way we experience and express our capacity for relational connection is the start of a cascade whose effects extend from the cognitive to the cellular with far-reaching consequences.

In summary then, the model suggests a point of interaction between allostatic control mechanisms and predictive modeling arising from a complex system of social decoding and response, with poor relational experience leading to brisker responses at lower levels of social threat and stress. In essence, the “feel” of relationality—how it is realized—acts as a constraining influence on parts of the social monitoring system in order to maximize appropriate response in the system as a whole. However, as has been earlier noted, it is not the acute responses to stressors *per se* that are necessarily injurious to health—indeed such responses are called up to maintain health in the face of environmental changes. The difficulty arises when responses are engaged too frequently or sustained inappropriately and allostatic overload occurs. In these situations, alterations in sensitivity leading to overstimulation and overproduction in one part with consequent development of receptor resistance to circulating signalers in another can, because of the complexity of the interplay between the sympathetic nervous system and the hypothalamic-pituitary axis, lead to chronic dysregulation with downstream effects with health implications. In this respect, the wide-ranging

effects of the cytokine signaling system at every level from the cellular through to the behavioral are clearly crucial because overproduction of pro-inflammatory forms of the molecules, if sustained, is likely to have implications for health. The last piece of the model is hence to suggest that poor relational quality has both short- *and* long-term consequences for allostatic maintenance. Thus it leads to greater amplitude allostatic responses, triggered at lower thresholds and more frequently in its own right, for the reasons outlined; but in addition, the constant resetting of sensors and effectors leads, over time, to chronic dysregulation in allostatic maintenance systems, with raised levels of circulating pro-inflammatory cytokines—something that in time can lead to long-term health consequences of the kind noted in epidemiological studies.

#### NEUROTHEOLOGY: PRODUCT OR PROCESS?

I want finally to return to the question of neurotheology as a coherent and sustainable enterprise and the extent to which the approach outlined and employed here has answered or not answered the criticisms raised in the first article (Bennett 2019a). In that article I argued that both Ashbrook's and Newberg's attempts to develop and delineate a neurotheological enterprise suffered from a number of serious problems regarding the triple metric of engagement, which I have used as a heuristic throughout these articles. I suggested that for neurotheology to successfully establish itself as a significant and sustainable arena within the wider field of science/religion dialogue, with respect to "encounter" better specification of dialogical loci was needed if the project was not only to avoid built-in obsolescence, but also to remain manageable and retain a coherent sense of identity; regarding "exchange," that a robust and defensible methodology was required along with a careful selection of contributory materials—particularly if both science and theology were to make a genuine contribution to the expansion of knowledge; and finally that "expression" necessitated not just the generation of coherent outputs that expanded understandings, but also the development of a distinctively neurotheological discourse.

The extension of van Huyssteen's interdisciplinary dialogical model which was set out and employed here addresses the first two of these requirements comprehensively and with demonstrable success—bringing together theology, cognitive neuroscience, and PNI in a transversal space conversation to explore a specific question raised in an area of shared interest, which was beyond the capacity of any one discipline to answer from within its own resources. The transversal space model's own inherent dynamics, and the associated tools of postfoundational rationality that support these, enabled the selection of rationally defensible and—from the theological side—distinctively different types of contribution to the science/religion debate. Finally, moving the locus of disciplinary parity

from the specific methodological to the shared rational, with the associated movement of epistemic standards from the domain-specific to those that are integral to the nature of rationality itself and the reconfiguring of the epistemic quest in terms of making progress toward optimal understanding in any given situation has, I would argue, provided a decisive way of overcoming the asymmetry that has been a notable and constant feature of science/religion dialogue. These moves, in conjunction with the associated possibilities of transversal outcomes enabled by the proposed extension to the model, have enabled theology to make an equal contribution alongside that of science to the expansion of understanding in the area under exploration. In so doing the model has also met the first part of the final suggested requirement—the generation of coherent outputs that make a contribution to optimizing understandings.

Ultimately, however, it remains a moot point as to whether either the arguments or the model generated can be properly labeled “distinctively neurotheological.” I would favor the more modest terminology employed in this article of “neurotheologically informed” and in keeping with this to argue that, ultimately, neurotheology is much more fruitfully understood and engaged with as a transversal *venture* rather than a hybrid *discipline*, that is, as *process* rather than *corpus*. I believe that such an approach opens up a potentially very fruitful new way of bringing together the “trades” of theology and science with their very different “gear and tackle and trim”—one that not only addresses some of the tensions outlined in the first article of this set but which might also help us rediscover how to build the rich, thick, and textured knowledge that this complex and variegated world demands.

## NOTES

1. I use the term science/religion rather than science/theology as this is the most commonly used designator of the field.
2. The neologism is used throughout these articles to refer to the human capacity to form and sustain relational connections with others.

## REFERENCES

- Bennett, Pat. 2013. *Relationality and Health: Developing a Transversal Neurotheological Account of the Pathways Linking Social Connection, Immune Function, and Health Outcomes*. Unpublished doctoral thesis, Oxford Brookes University.
- . 2019a. “‘Landscape Plotted and Pieced’: Exploring the Contours of Engagement between (Neuro)science and Theology.” *Zygon: Journal of Religion and Science* 54:86–106.
- . 2019b. “‘Things Counter, Original, Spare, Strange’: Developing a Postfoundational Transversal Model for Science/Religion Dialogue.” *Zygon: Journal of Religion and Science* 54:107–28.
- Berkman, Lisa F. 1995. “The Role of Social Relations in Health Promotion.” *Psychosomatic Medicine* 57:245–54.
- Burklund, Lisa J., Naomi I. Eisenberger, and Matthew D. Lieberman. 2007. “The Face of Rejection: Rejection Sensitivity Moderates Dorsal Anterior Cingulate Activity to Disapproving Facial Expressions.” *Social Neuroscience* 2:238–53.

- Cohen, Sheldon. 1988. "Psychosocial Models of the Role of Social Support in the Etiology of Physical Disease." *Health Psychology* 7:269–97.
- Graunt, John. [1662] 1939. *Natural and Political Observations Mentioned in a Following Index, and Made upon the Bills of Mortality*. Reprint Ed. Baltimore, MD: Johns Hopkins University Press.
- Haack, Susan. [1993]2009. *Evidence and Inquiry: A Pragmatist Reconstruction of Epistemology*. Amherst, NY: Prometheus Books.
- Hackett, Ruth A., Mark Hamer, Romano Endrighi, Lena Brydon, and Andrew Steptoe. 2012. "Loneliness and Stress-Related Inflammatory and Neuroendocrine Responses in Older Men and Women." *Psychoneuroendocrinology* 37:1801–09.
- Hanley, Katherine. 1995. "Gabriel Marcel and Postmodernism: Reflections on a Broken World." *Bulletin de la Société Américaine de Philosophie de Langue Française* 7:122–47.
- Holt-Lunstad, Julianne, Timothy B. Smith, and J. Bradley Layton. 2010. "Social Relationships and Mortality Risk: A Meta-Analytic Review." *PLoS Med* 7:e1000316.
- House, James S., Karl R. Landis, and Debra Umberson. 1988. "Social Relationships and Health." *Science* 241:540–45.
- Irwin, Michael R. 2008. "Human Psychoneuroimmunology: 20 Years of Discovery." *Brain, Behavior and Immunity* 22:129–39.
- Korte, S. Mechiel, Jaap M. Koolhaas, John C. Wingfield, and Bruce S. McEwen. 2005. "The Darwinian Concept of Stress: Benefits of Allostasis and Costs of Allostatic Load and the Trade-Offs in Health and Disease." *Neuroscience and Biobehavioral Reviews* 29:3–38.
- Masten, Carrie L., Eva Telzer, Andrew J. Fuligni, Matthew D. Lieberman, and Naomi I. Eisenberger. 2012. "Time Spent with Friends in Adolescence Relates to Less Neural Sensitivity to Later Peer Rejection." *Social Cognitive and Affective Neuroscience* 7:106–14.
- Robles, Theodore F., and Heidi S. Kane. 2012. "Marriage." In *The Oxford Handbook of Psychoneuroimmunology*, edited by Suzanne C. Segerstrom, 197–213. Oxford, UK: Oxford University Press.
- Roskies, Adina L. 2010. "Neuroimaging and Inferential Distance: The Perils of Pictures." In *Foundational Issues in Human Brain Mapping*, edited by Stephen J. Hanson and Martin Buzl, 195–215. Cambridge, MA: MIT Press.
- Schrag, Calvin. O. 1994. "Transversal Rationality." In *The Question of Hermeneutics: Essays in Honour of Joseph J Kockelmans*, edited by Timothy J. Stapleton, 61–78. Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Sterling, Peter. 2004. "Principles of Allostasis: Optimal Design, Predictive Regulation, Pathophysiology and Rational Therapeutics." In *Allostasis, Homeostasis, and the Costs of Physiological Adaptation*, edited by Jay Schulkin, 17–64. Cambridge, UK: Cambridge University Press.
- Swinton, John. 2000. *From Bedlam to Shalom: Towards a Practical Theology of Human Nature, Interpersonal Relationships and Mental Health Care*. New York, NY: Peter Lang.
- Uchino, Bert N. 2006. "Social Support and Health: A Review of Physiological Processes Potentially Underlying Links to Disease Outcomes." *Journal of Behavioral Medicine* 29:377–87.
- Uchino, Bert N., Allison A. Vaughn, McKenzie Carlisle, and Wendy Birmingham. 2012. "Social Support and Immunity." In *The Oxford Handbook of Psychoneuroimmunology*, edited by Suzanne C. Segerstrom, 214–33. Oxford, UK: Oxford University Press.
- von Balthasar, Hans Urs. 1990. *Theo-Drama: Theological Dramatic Theory*, Vol. 2. San Francisco, CA: Ignatius Press.
- Westhelle, Vitor. 2000. "Theological Shamelessness? A Response to Arthur Peacocke and David A. Pailin." *Zygon: Journal of Religion and Science* 35:165–72.