# Embedding human well-being in the body, social relations, and the more-than-human world: towards a framework for understanding whole-systems well-being

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## List of Abbreviations

ADD – Attention deficit disorder
ANS – Autonomic nervous system
ART – Attention restoration theory
BBS – Biobehavioral synchrony
CAN – Central autonomic network
CIS – Critical interpretive synthesis
CT – C-tactile
CTRA – Conserved transcriptional response to adversity
EE – Ecological economics
fMRI – Functional magnetic resonance imaging
GC – Glucocorticoid
GCR – Glucocorticoid receptor resistance
GDP – Gross domestic product
HEP – Heart-evoked potential
HPA – Hypothalamic-pituitary-adrenal cortical [axis]
HRV – Heart rate variability
IGT – Iowa gambling task
IMP – Ideologically motivated processing
IPNB – Interpersonal neurobiology
IPP – Interoceptive predictive processing
IWM – Internal working model
LEAS – Levels of emotional awareness scale
MAIA – Multidimensional assessment of interoceptive awareness
mPFC – medial Prefrontal cortex
NCE – Neoclassical economics
NDF – Non-defensive functioning
OT - Oxytocin
PE – Prediction error
PFC – Prefrontal cortex
PNS – Parasympathetic nervous system
PP – Predictive processing
PSI – Perceived social isolation
PTSD – Post-traumatic stress disorder
PWB – Psychological well-being
RPP – Relational predictive processing
SDT – Self-determination theory
SCR – Skin conductance response
SNS – Sympathetic nervous system
SWB – Subjective well-being
vmPFC – ventromedial Prefrontal cortex
WB – Well-being
WHR – World happiness report
WSWB – Whole-systems well-being

## Contribution of Authors

I (John Adams) am the sole author of this work.

Abstract

The dominant mode of societal operation in today's world, in its pursuit of the good life through economic growth and consumption, is destroying the planet's ecosystems and accelerating towards an inhospitable climate regime, with mixed results for even short-term human well-being. This pathological mode of societal operation is based in discredited worldviews. However, important aspects of a coherent, updated worldview have not been articulated and thus have not been integrated into the efforts of scholarship to steer society away from collapse and toward sustainable, desirable futures. In particular, there is a need for an explanatory framework that makes sense of seemingly incompatible perspectives on the human being (e.g., between the natural and social sciences) and on human well-being (WB; e.g., between hedonic and other perspectives)—and that situates human WB in the context of planetary WB. This thesis lays the foundation of such a framework. Previous researchers taking a complex-systems approach have argued convincingly that self-regulatory capacity is the underlying basis of WB, providing a key premise for this thesis. I synthesize evolutionary, neurobiological, psychological, and social lines of investigation into a coherent, broadly consistent understanding of the development and dynamics of self-regulatory capacity, focusing on various interdependent levels of regulation (e.g., physiological, psychological, and social) and showing many of their impacts on WB. With the help of *predictive processing* models of perception, this thesis explores how self-regulatory dynamics are affected by the qualities of three key relationships fundamental to the human situation: relationship with one's body (embodiment), relationship with other humans (sociality), and relationship with the more-than-human world (terrestriality).

This work suggests a number of conclusions. First, all three of these relational contexts (embodiment, sociality, terrestriality) are fundamental to both our existence and our well-being. It follows that any coherent worldview must account for these dynamic interrelations. Second, human well-being may be proximally defined by the capacity for integrated, non-defensive functioning, which is a developmental achievement dependent on supportive conditions. Third, beyond material sufficiency, the most important factors for WB seem to be attentional, collective, and mutualistic, rather than consumptive, individual, and rival.

This thesis, by synthesizing a variety of scientific disciplines into a coherent framework for an embedded, complex-systems understanding of whole-person health and well-being, is the first part of a research agenda toward understanding—and achieving—*whole-systems well-being*, from person to planet.

Résumé

Le mode dominant de fonctionnement social du monde contemporain, axé sur la poursuite de la vie bonne à travers la croissance économique et la consommation, détruit les écosystèmes planétaires et accélère la transition vers un régime climatique inhospitalier, produisant paradoxalement des résultats mitigés quant au bien-être humain dans le court terme. Ce mode de fonctionnement social pathologique repose sur une vision du monde discréditée. Toutefois, d'importantes dimensions d'une vision du monde cohérente et actualisée n'ont pas encore été articulées, et par conséquent intégrées dans les travaux académiques visant à réorienter l'évolution de la société dans la direction souhaitable de la soutenabilité socio-écologique. Précisément, il existe un besoin urgent d'un cadre d'analyse explicatif expliquant différentes perspectives, a priori contradictoires, sur l'être humain (entre les sciences sociales et naturelles) et son bien-être (entre les perspectives hédoniques et d'autres) situant le bien-être humain en cohérence avec le bien-être du système planétaire. Cette thèse établit les fondations d'un tel cadre d'analyse. Les recherches passées ayant adoptées une perspective axée sur les systèmes complexes ont soutenues de manière convaincante que les capacités d'autorégulation forment la base du bien-être, fournissant ainsi une prémisse clé de cette thèse. Cette thèse synthétise des axes d'investigation neurobiologiques, psychologiques et évolutionnaires au sein d'une compréhension cohérentes des développements et des dynamiques d'autorégulation en se concentrant sur une variété de niveaux d'autorégulation interdépendants (physiologiques, psychologiques et sociaux) en montrant leurs impacts sur le bien-être. À l'aide de modèles de *traitement prédictif* de la perception, cette thèse explore comment les dynamiques d'autorégulation sont affectées par les qualités de trois relations fondamentales à la situation des êtres humains : la relation entretenue avec son propre corps (corporéité), avec les autres êtres humains (la socialité) et avec le monde plus qu'humain (terrestrialité).

Ce travail propose une série de conclusions. Premièrement, ces trois contextes de relations sont fondamentaux à notre existence et à notre bien-être. Par conséquent, toute vision du monde (worldview) actualisée doit prendre en considération ces interrelations dynamiques. Deuxièmement, le bien-être peut-être proximalement défini comme un fonctionnement intégré et non-défensif, résultat d'un développement dépendant de conditions favorables de support. Troisièmement, au-delà de la suffisance matérielle, les facteurs les plus importants du bien-être semblent être liés à l'attention, au collectif et à la mutualité plutôt qu'à la consommation, à l'individuel, et à la rivalité.

Cette thèse synthétise les approches proposées par différentes disciplines scientifiques au sein d'un cadre d'analyse cohérent, intégré et épousant les approches basées sur les systèmes

complexes quant à une définition holistique du bien-être et de la santé humaine. Elle constitue la première partie d'un programme de recherche visant la compréhension – et l'accomplissement – d'un bien-être systémique et holistique, allant de la personne vers l'environnement planétaire.

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# Chapter 1: Introduction

## 1. Overview

Our current societal operating system is producing disastrous consequences. Its foundational ideas (relating to ontology and societal goals) need updating if we wish to theorize and implement ways of living together that sustain and enhance possibilities not just for life, but for the good life. To inform those possibilities, this thesis seeks to produce an integrative framework for considering the human and well-being. Situating the human in its contexts of body, social relations, and the more-than-human world, using a transdisciplinary, systems approach, offers a basis for a consilient view of the human and of well-being.

## 2. Anthropocene as time of crisis

The dominant modes of societal operation have led to an era termed the Anthropocene (Oldfield et al., 2014), characterized by human activity of a scale and manner that has disrupted the biogeochemistry of the earth system and led to multiple interrelated crises in climate, biodiversity, and geopolitical instability – and threatening a collapse into an inhospitable climate regime (IPCC, 2019; Steffen et al., 2018, 2015).

### 2.1. Institutions as intermediate cause

These crises are outputs of particular modes of societal organization and function, which (implicitly and explicitly) structure our relations with each other and the rest of the planet; i.e., institutions[1]. Recognizing that solutions to these crises will not be reached within present institutional designs, many have pointed to the need for radical restructuring (e.g., Costanza et al., 2015; Díaz et al., 2019; Klein, 2014). For instance, summarizing a study he led (O'Neill et al., 2018), O'Neill writes, "No country currently meets the basic needs of its citizens at a globally sustainable level of resource use"; therefore "radical changes to physical and social provisioning systems are required."[2]

## 3. Worldview as deeper source

While these global crises have been generated by institutional design, those institutions themselves

[1] Hodgson defines institutions as "integrated systems of rules that structure social interactions," with a rule being "a learned and mutually understood injunction or disposition" (Hodgson, 2015, pp. 501–502). As emphasized here, these systems also structure social-ecological interactions. Important also to recognize is that these modes/systems find expression not only in social infrastructure like laws and markets, but in physical infrastructure like roads and power plants. O'Neill et al.'s framework addresses both physical and social arrangements oriented to meeting our needs and desires as "provisioning systems".

[2] The commentary from which this quote is taken is available at https://sustainabilitycommunity.springernature.com/posts/29930-living-well-within-planetary-boundaries

can be understood as having arisen from outdated and maladaptive worldviews (Berry, 1999; Crist, 2018; Tarnas, 1991). As the legendary systems theorist Donella Meadows put it, "from shared social agreements about the nature of reality, come system goals […] and everything else about [our] systems" (Meadows, 1999, p. 18).

Thus, worldview and, closely tied to that, the sense of the aim or goal of society, are crucial areas of investigation in the process of societal reorientation. In describing places to intervene in a system, Meadows ranked the goal of the system and "the mindset or paradigm out of which the system arises" as behind only the transcendence of paradigms altogether as the most potent *leverage points* in a system (Meadows 1999). A particularly important element of a worldview is how it conceives of the human. Indeed, any political philosophy—that is, any prescriptive theory for the organization and function of society—is at least implicitly based on some model of the human being and a vision of the good life (McShea, 1978).

Other scholars' prescriptions for course-correction out of the Anthropocene match these insights. The first of three questions Brown (2015, p. 68) identifies as "essential to answer if we are to construct a sane and safe future for ourselves and the other life-forms with which we share heritage and destiny" is "What is the nature of the person?" Additionally, a panel of experts involved with the most recent IPBES[3] global assessment listed the number one leverage point for societal transformation as "visions of the good life" (Chan et al., 2020).

This thesis works at the intersection of these two elements (i.e., views of human beings and of well-being) towards a foundation for a political philosophy of whole-systems well-being—one that is good for us and for the planetary systems we rely on. In current societal operation, however, one particular "formulation of what it is to be a human being in search of well-being […] dominates public policy and discourse alike" (Brown and Timmerman, 2015, p. 2)—that of mainstream "neoclassical" economics.

## 4. Human Nature and the Good Life according to neoclassical economics

Neoclassical economics (NCE) assumes that human beings are exclusively self-interested. Self-interest, in this model, specifically means maximizing one's "utility", where utility is achieved through market consumption. For this "rational actor"[4], more is always better. Thus, the good life according to NCE is simply: More.

The assumption that more consumption is the route to achieving well-being (WB) has led

[3] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
[4] This notion of "rationality" as (Gintis, 2000, p. 320) emphasizes, does not resemble or follow from either a common or rigorous understanding of rationality.

to a conflation of monetary measures—income, or on a societal scale, GDP[5]—with WB or "quality of life". Despite widespread and justified critique of the use of GDP as a proxy for WB, and the increasingly dire warnings of scientists that the scale of economic activity is disrupting the planetary processes we depend on, GDP growth remains (as an apparent paradox; Orr, 2020; Coscieme et al., 2019) the primary policy goal of almost every government (Bergh, 2009; Raworth, 2017).

In explaining this "paradox of growth", Orr (2020) uses a geologic metaphor to describe temporal processes in paradigm formation and change. Once-contested ideas can win out, so to speak, and become accepted and assumed in a culture. These beliefs (now considered "common sense") may over time become sedimented in deeper layers and strata of the collective ground, framing and limiting thought and discourse. These processes of sedimentation and relatively superficial contestation of ideas, characteristic of "settled times", are punctuated by "unsettled times", in which deeper layers become contested once again and are potentially excavated.

## 5. Fundamental ontological dichotomy: humans as separate from nature

At the bottom of the paradigmatic geology are bedrock *ontological* assumptions (i.e., about the nature of being and reality)—in this case, deep old themes of western thought that shape our experience of ourselves and the world. The quintessential example is the dualism of human and nature, which expresses itself in many ways as separate basic "realities": mind/body, nurture/nature, culture/biology, spirit/flesh, subjective/objective (e.g., Oyama, 2000; Tarnas, 1991; Whitehead, 1920).[6] Accordingly, it also divides realms and methods of academic study into the humanities and social sciences on the one hand, and the physical and natural sciences on the other (cf. Snow, 1959), with their associated philosophies of relativism and reductionism (Tarnas, 1991), discussed below.

This human/nature dichotomy is a prime suspect in the genesis of the Anthropocene (Berry, 1999). As we'll see in the next chapter, it also impacts the way WB has been studied and conceptualized. Though these dichotomies have remained "common sense", their scientific basis has been deeply eroded over the last decades by many streams of investigation—particularly, as we shall see, by the study of complex systems.

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[5] GDP (Gross Domestic Product) is a monetary measure of the total value of goods produced and services provided on the market in a single year.

[6] Attesting to the pervasiveness and impact of this ontological rift throughout the strata of thought, Oyama (1991, p. 28) describes such a division as "less a dichotomy than a sprawling complex of multiply interconnected beliefs, metaphors, and associations (Oyama, 1985, 1988). It is not easily disposed of, for it is deeply embedded in our thought, and it has as many conceptual relatives as it has guises."

## 6. Consilience via a complex systems approach

Many scholars have noted the potential of a complex systems approach to resolve the fundamental dichotomy between humans and nature (e.g., Kauffman, 2008; Prigogine and Stengers, 1984). Such a resolution, bringing the humanities and natural sciences into agreement, is termed *consilience*. In order to express the consilience of complex systems, this section notes some basic features of a reductionist worldview, pervasive on the natural science/matter/nature side of the dichotomy, before briefly addressing the counterpart on the social science/mind/human side, in the form of relativism. I then briefly indicate how the associated problems of each are resolved in a complex systems view.

### 6.1. Reductionism: flattening

Reductionism, speaking generally, is the practice of explaining phenomena by breaking them down into their constituent parts. This practice often carries with it the metaphysical assertion that the parts are the more real, the causative, and that the whole can be reduced to and totally explained by the parts. The depth of reality we see in the hierarchical arrangement of parts into larger wholes is treated as an illusion, the mere superficial appearance of the flat reality of the smallest pieces. This view is exemplified by physicist and Nobel laureate Steven Weinberg, who claimed that "the explanatory arrows always point downward" (Weinberg, 1994); i.e., from societies down to quarks, it is the parts that explain the wholes. Reductionism is not the sole purview of physics; reductionists in the field of evolutionary biology try to flatten the rich realm of human agency and motivations down to the single end of perpetuating genes: "[w]e are survival machines—robot vehicles blindly programmed to preserve the selfish molecules known as genes" (Dawkins, 1976, p. ix). Similarly, E. O. Wilson's "sociobiology", though attempting consilience, was in fact rooted in a reductionist framework (Wilson, 1975; see Kahn, 2011, Ch. 2).

### 6.2. Relativism: free-floating

The New Oxford American dictionary defines relativism as "the doctrine that knowledge, truth, and morality exist in relation to culture, society, or historical context, and are not absolute". The maintenance of this halo of ineffability around human concerns has served to defend against two potential threats (Tarnas, 1991). One is the philosophical voiding of human values that would seem to follow from flattening them to the mere dance of particles to the tune of physical law. The second is the idea that, if human values and cultural activities are subjected to a domain of knowledge claiming judgmental authority, then individuals and cultures would lose the justification to self-determination. Cultural relativism protects against this danger by adopting a strictly observational, non-critical position. However, such a position precludes an explanatory theory of the human or of

what its WB entails. This free-floating ontology provides no guidance for a political philosophy for achieving WB. As Martha Nussbaum writes,

> the view that human life has certain central defining features is linked by its opponents with an ignorance of history, with lack of sensitivity to the voices of women and minorities. It is taken, usually without extended argument, to be in league with racism and sexism, with "patriarchal" thinking generally, whereas extreme relativism is taken to be a recipe for social progress. […] I argue that those who would throw out all appeals to a determinate account of the human being, human functioning, and human flourishing are throwing away far too much – in terms even, and especially, of their own compassionate ends. […W]ithout such an account, we do not have an adequate basis for an account of social justice and the ends of social distribution. With it, on the other hand, we have – what we urgently need at this time – the basis for a global ethic and a fully international account of distributive justice. (Nussbaum, 1992, p. 205)

### 6.3. Complex systems: grounded and emergent

With complex systems, in contrast to the reductionist view, what emerges as a result of interactions of the parts constitutes a whole that is more than the sum of the parts. That higher-level whole is not caused, in the deterministic sense, but simultaneously *enabled and constrained* by the existence and organization of the parts (Kauffman, 2008). In other words, the whole is dependent on but not reducible to the parts. In addition, such emergent wholes also have causal efficacy downward to the parts, as well, often in mutually reinforcing ways (Kay, 2008). Indeed, one of the basic general functions of higher levels of complex systems is to *organize* and *direct* the processes of the lower levels—a striking refutation of the reductionist dismissal of their importance.

In contrast to a free-floating relativism, a complex systems view of high-level phenomena acknowledges their basis in the structures and processes of lower levels of the system. To the extent that these lower levels are understood, this recognition provides the foundation for a critical, explanatory theory of the constitution and dynamics of the high-level phenomena. As an example, let us consider the heart as a complex system and examine its actions. To understand what a heart *is* and what it *does*, we look at the organ as a whole and at its relationship with the broader systems of which it is a nested part (Bernard, 1865). However, the *composition* of the heart can be understood from the system's lower levels, i.e., the smaller nested systems it comprises (atria/ventricles, tissues, cells), and likewise for the composition of the heart's behavior. To understand *how* the heart circulates blood throughout the body, we study the component *functions* of each chamber as a pump, the *processes* of contraction, and—crucially—the *coordination*

between all of the subsystems involved, at each hierarchically organized layer (Smith et al., 2017). In this way, we begin to build a coherent theory of the heart, grounded in the simpler workings of its simpler components, that neither reduces its identity to a collection of parts nor leaves its nature an indeterminate matter of conjecture.

As an illustrative example of consilience, modern biologists have recognized the old *gene vs. environment* (nature vs. nurture) debate as based on false premises (i.e., it is a false dichotomy). Current research aims to better understand their *dynamic interrelationship* as the best basis for understanding either. That is, genetic reductionism/determinism is not supported by current science: as complex systems, living organisms cannot be reduced to their genes, just as they cannot be reduced to subatomic particles. Biological processes emerge out of, but are not reducible to, *and in turn affect*, the physical and chemical processes they emerge from.

The same holds true for the higher levels of systems of organisms as well: culture emerges out of, is not reducible to, and in turn affects, interactions between organisms. In this way, an ontology grounded in complex systems understandings leaves plenty of room for personal and cultural values, differences, and freedoms. These phenomena exist at their own level of analysis, but crucially, they are grounded in lower levels, not severed or free-floating. Thus, such a complex systems view does not flatten human values or dictate cultural modes, but it does provide illumination on the origins, preconditions, and relational dynamics of such high-level concerns—including WB. Along these lines, this thesis demonstrates the importance of the interrelated dynamics of various neurobiological, psychological, and social processes in order to come to a grounded, consilient understanding of the human being, and of human well-being. The next chapter provides more explanation of this approach.

## 7. Common pitfalls in efforts toward sustainability

The premise being made here is that efforts out of the crises of the Anthropocene will be most likely to succeed if they have a firm footing in a consilient, non-dichotomous worldview. However, sustainability science often fails to investigate or engage with these deeper root causes of unsustainability (Abson et al., 2017). Despite widespread recognition of the need for transdisciplinary approaches that account for interactive, emergent properties of the systems in play, reductionist, discipline-specific orientations have remained the norm (Spangenberg, 2011). Further, much of the effort towards sustainability seems focused on "quick fixes" within the current paradigm (Ehrenfeld, 2004), rather than considering a substantive vision toward which to aim. As a result, discussions of "sustainability" too seldom give serious thought to what it is

intended that we sustain, and too often simply aim to reduce the negative impacts of the present structures.

These shortcomings stem from a common failure to question elements of the underlying pervasive assumptions that constitute the dominant worldview. Such unexamined assumptions influence our approach to problems and what gets included in our analyses. One expression of a lack of engagement with this more fundamental level of analysis is in formulations of "sustainability" that do not challenge, or that champion, economic growth as a primary goal (e.g., "green growth", "sustainable development"). These formulations ignore the incompatibility between continued economic growth and a sustainable society (Daly, 2015; Martin et al., 2016).

## 8. Ecological Economics

Notable among the fields aiming to steer out of the catastrophic Anthropocene is ecological economics (EE). EE's foundational insight takes the form of a worldview update, emphasizing that the economy is embedded in the biophysical and social-ecological world[7], and thus the impossibility of endless economic growth on a finite planet (Daly and Farley, 2011). This "pre-analytic vision" (i.e., ontology) of the economy depicts the realm of human activity in a dynamic and dependent relationship with the rest of the planet's activity. Accordingly, as a transdiscipline, it engages broad inter-system interactions. It is therefore exceptional in relation to the common pitfalls mentioned above.

EE aims to theorize (and support the achievement of) societal institutions and ways of living that are consistent with the aims of "sustainable wellbeing" (Costanza et al., 2020) and mutually beneficial human-earth relations (*à la* Berry, 1999; Vargas Roncancio et al., 2019). That is, it seeks a scientifically grounded political philosophy for whole-systems well-being. However, though it is critical of the dominant model of the human as "rational actor", it has not articulated the "embeddedness" of the human as it has done for the economy. EE thus still lacks a compelling theory of the human being.[8] In addition, though EE draws from the literature on WB in contesting the consumption narrative of the good life, the WB literature itself suffers from a lack of consilient theory (see next chapter); that is, there is also a need for a compelling theory of well-being.

[7] That is, as opposed to the other way around. Mainstream accounts invert this reality, depicting the planet (as "natural resources") as a part of the economy.

[8] This is not to say that there have not been proposals. Of the many piecemeal "*Homo*"s offered as alternatives to the dominant "*Homo economicus*", *Homo ecologicus* aims for a similar embedding, but does so by appeal to the romantic philosopher Novalis (Becker, 2006). *Homo efficens* synthesizes science accounting for the non-rational and social elements of human cognition, but it is focused on human decision-making (Levine et al., 2015).

## 9. Research Objective

This thesis focuses on the intersection of these two fundamental gaps. Paralleling EE's pre-analytic embedding of the economy in the biophysical and socio-ecological, this thesis investigates the relevance of human embeddedness—as *embodiment, sociality, and terrestriality*—for human well-being. Going beyond the mere fact of embeddedness, I explore how the *quality of the connection* to the body, other humans, and the more-than-human world plays a key role in the various levels of function (physiological, psychological, social) that shape the human experience and form the basis of health and WB. In working at this important intersection, I aim to clarify both the phenomenon of well-being and the embeddedness of the human.

# Chapter 2 – Literature Review

## 1. Overview

The first part of this chapter provides an overview of prominent conceptions of well-being (WB) and their associated lines of study. There has been a remarkable amount of research in this field in recent years; this is therefore not an exhaustive but a representative review. After this brief overview, I address a gap in the literature, discussing research that borders on, but does not bridge across, this gap. Part of the issue identified is that much WB research lacks a firm theoretical framework. Finally, in the last portion of this chapter, I describe the basis for the approach to WB taken in this thesis: an evolutionarily and neurobiologically grounded "organismic" view that treats the human as a complex system that develops and lives in dynamic relationship with its social-ecological context. A central tenet is that anything reasonably considered WB is predicated on self-regulation at various levels of function.

## 2. Well-being: Hedonic and Eudaimonic

Approaches to the study and attainment of WB have generally been categorized as oriented to *hedonia* or *eudaimonia* (Ryan and Deci, 2001). The hedonic approach is oriented to pleasure, that is, positive or desired feeling states, whether sensory or emotional. It is outcome-oriented. On the other hand, the eudaimonic approach is variously oriented to function, excellence, meaning/purpose, or actualization. It is process-oriented. As described next, these approaches have particular expressions in philosophy, psychology, and economics. The philosophical precursors are only briefly mentioned, before focusing more on approaches within the arenas of psychology and economics.

## 3. Philosophy

The hedonic approach to WB traces back to Aristippus of Cyrene and Epicurus, and more recently to the utilitarian philosophers Jeremy Bentham and John Stuart Mill. The concept of eudaimonia was developed by Aristotle in the context of his virtue ethics. Commonly translated as "flourishing" or "thriving", eudaimonia denotes a fully functioning way of living; it is seen as the highest good and *telos* (end goal) of human beings. In conceiving "the good we are seeking", Aristotle did not view being or well-being as passive, but rather placed emphasis on the actions that constitute living; thus, as being involves doing, being well involves doing well.

For philosophers, these approaches constitute different views of human nature, upon which are based normative, ethical philosophies. Further, though Epicurus recommended a retreat from political life, the views of Bentham, Mill, and Aristotle also formed the grounds for political

philosophies.

## 4. Psychology

The hedonic measure of WB takes the lion's share of attention in the field of psychology. The ease of its assessment has allowed researchers to accumulate an impressive amount of correlative data using large poll samples. Other researchers have employed a variety of eudaimonic formulations of WB, with varying degrees of adoption in the field.

### 4.1. Hedonic: Subjective well-being

The dominant measure in the field, administered widely in global polls, has three parts, all self-reported. It consists of responses to questions about positive (pleasant) emotion, negative (unpleasant) emotion, and a question about overall "life satisfaction".[9] This tripartite measure is referred to as "subjective well-being" (SWB). Though economists and psychologists have studied the correlation of SWB with a number of national-level variables and averages, including GDP (discussed below), psychologists have also studied its association with personality attributes and other individual circumstances. (e.g., DeNeve & Copper, 1998). Further, longitudinal studies have been able to shed light on causation (Diener, 2013; Diener et al., 2018). For example, married people tend to be happier, but at least part of that correlation is due to the fact that happy people are more likely to get married and stay married (Diener, 2013).

#### 4.1.1. SWB is Atheoretical

Though it has generated an impressive amount of data, the hedonic approach is basically atheoretical (Kashdan et al., 2008). Indeed, it counts that as a strength: by not presuming what people should value, but instead relying on people's own self-reports, researchers avoid "potential elitism" (Kashdan et al., 2008, p. 227). As expressed by Ed Diener, who has championed SWB since 1984, "Scientists studying SWB do not prejudge what people will consider a good life for themselves, but instead rely on the judgements respondents themselves provide, based on whatever criteria research participants deem to be most important" (Diener et al., 2018, p. 253). However, it is not evident that their questions' content and framing would be universally endorsed as representative of WB (Delle Fave et al., 2016; Krys et al., 2019; Ruggeri et al., 2020). Indeed, it draws much critique (e.g., Austin, 2016; Ryan and Huta, 2009; Ryff, 1989a). Thus, in some sense, this measure has merely shifted the assumption of what is valuable in a human life out of sight. As

[9] Life satisfaction, in contrast to the two "affective" (emotional) measures, is considered the cognitive element of SWB, sometimes called "evaluative". In what could perhaps be termed the pure hedonic (Kahneman calls this "objective happiness"), some see evaluation as potentially distortive, even preferring to tally in-the-moment emotional reports, due to the unreliable accuracy of memory in reporting yesterday's emotions (Kahneman, 1999; Stone et al., 1999), but this is a minority position.

we address next, this deprives SWB of the critical lens that a sound clinical approach demands.

#### 4.1.2. SWB precludes a critical perspective

Though some look no further than SWB for the definition of WB, SWB may better be treated as an imperfect indicator. As Ryan and Huta point out, someone's grief at the loss of a good friend is a sign of health; whereas a well-connected addict's high degree of positivity is not:

> We agree that *happiness* is subjective, and that self-report is the most direct way to assess *that* construct. But neither well-being nor psychopathology can be fully assessed by happiness. Imagine applying this definition of wellness in clinical contexts. We regularly see patients who feel happy or satisfied (such as the person with bipolar illness early in a manic phase, the narcissist during prideful times, or a well-supplied drug addict) but who do not exemplify well-being. We also see people appropriately low in SWB following a loss, and consider their capacity to grieve an expression of wellness. As such examples illustrate, critical to defining well-being is *considering the functions and processes through which subjective states accrue*. This is not elitist; it is simply good clinical practice. (Ryan and Huta, 2009, p. 203, emphases original)

The impossibility of a critical perspective on peoples' self-reports in SWB closely parallels the same impossibility found in relativism with respect to cultural differences, prohibiting a theory of something more fundamental that could ground the otherwise free-floating observations. However, as indicated by the research we discuss next (and as elaborated by this thesis), there is indeed something more fundamental.

#### 4.1.3. SWB is underwritten by development and regulatory function

Though SWB is inconsistent with clinical practice, clinical realities of mental illness are recognized as a strong determinant of SWB. As Layard et al. (2018, 2013) note, mental illness is the greatest contributor to "misery", defined as being in the bottom quartile of life satisfaction. Beyond that cognitive-evaluative aspect of SWB, the emotional aspects, too, are clearly impacted by mental illness. Emotional *dysregulation* is a defining characteristic of the gamut of psychiatric diagnoses—internalizing, externalizing, and psychotic forms of psychopathology, as well as personality disorders (Beauchaine and Cicchetti, 2019). Importantly, emotional *regulatory* capacity, crucial for a predominance of subjectively pleasant states, is achieved through context-dependent neural *maturation* and *connectivity* (Beauchaine and Cicchetti, 2019). Therefore, even if we were solely concerned with hedonic emotional experience, the functional concerns of *development* and *integration* are key elements of an explanatory theory. That is, such preconditions and processes of regulation are more fundamental to well-being than what is captured by SWB;

they are therefore central to this thesis's approach (described in section 6).

#### 4.1.4. Expanding SWB is problematic

Ed Diener has apparently been expanding the scope of the term SWB beyond mere self-report, including biological, cognitive, and response-time measures, as well as other people's reports of a target person's SWB, as further measures of "subjective well-being" (Diener et al., 2018, 2017). This is incoherent; the first three measures would more appropriately be termed objective, and the fourth intersubjective. Such an ambitious research program was bound to interface with other modes of inquiry, but to acknowledge the need for them is to acknowledge the limitations of purely subjective well-being.

Despite the shortcomings of SWB, much has been learned using the measure. We will return in section 5.2 to discuss its application at the national level. For now, we turn to eudaimonic approaches within psychology.

### 4.2. Psychological Eudaimonic

Eudaimonic approaches are more heterogeneous than the hedonic, ranging from the more philosophical to the more empirical (see Huta and Waterman (2014) for an excellent overview of various approaches to eudaimonia). I discuss two approaches of particular relevance to this thesis: Ryff's psychological well-being (PWB) and Ryan and Deci's self-determination theory (SDT).

#### 4.2.1. Psychological well-being

Carol Ryff is a pioneer of eudaimonic WB research in psychology. Her six dimensions of psychological well-being (PWB) are derived from philosophical and humanistic/existential psychological writings (Ryff, 1989b): autonomy, environmental mastery, personal growth, positive relationships, purpose in life, and self-acceptance. Ryff's dimensions measure orientations and qualities theorized as characteristic of flourishing. We return in section 5 to further aspects of Ryff's research. First, we take a first look at an approach that focuses on the needs, processes, and contexts for flourishing; that of self-determination theory.

#### 4.2.2. Self-determination theory

Self-determination theory (SDT) is a social-psychological meta-theory of human motivation, development, and well-being (Ryan and Deci, 2017). It studies how various contexts support or thwart the intrinsic motives through which inherent tendencies toward growth and integration (see section 7) are expressed. The outcomes in terms of WB are assessed according to a variety of measures and dimensions, from function, vitality, SWB, and motivation quality, to prevalence of somatic complaints like headaches. Decades of empirical study in SDT support the conclusion that the contexts most supportive of healthy development and WB are those that best satisfy three basic

psychological needs[10]: autonomy, relatedness, and competence.

*Autonomy* refers to agency or volition; an "internal perceived locus of causality" (de Charms, 1968); the degree to which one's behavior is consistent with, endorsed by, or sourced from within the self, rather than imposed, coerced, or manipulated from without. It is explicitly *not* a synonym for independence, detachment, or individualism; it is not autonomy "from". Indeed, it tends to be positively correlated with relatedness (Deci and Ryan, 2000, p. 242). *Relatedness* points to the need for social connection and belonging. *Competence* indicates effectiveness, mastery, and the developing of one's capacities (for in-depth discussion, see Ryan & Deci, 2017, Chs. 4 & 10).

SDT argues that, though part of the picture, hedonic notions of happiness miss much about thriving, or full functioning, which "is characterized by vitality, awareness, access to, and exercise of one's human capacities and true self-regulation" (Ryan and Deci, 2017, p. 241). SDT is a major exception to the general lack of theoretical coherence in WB research and psychology more generally, discussed below in section 6.1. We will return to how SDT informs this thesis's approach in section 7. For now, we turn to how WB has been treated in economics.

## 5. Economics

Economic discussions of welfare (i.e., WB) historically included views drawn from philosophy and the humanities, but the modern orthodox view has come to equate welfare with utility and utility with consumption, thus focusing exclusively on economic growth and consumption as the means to happiness. However, there has been increasing interest in SWB and its relation to GDP and other national-level variables. I discuss the World Happiness Report (WHR; Helliwell et al., 2020) as the prime example of this kind of endeavor. Eudaimonic conceptions of WB in economics focus on people's capacity to meet the needs and values present in their lives, seeing money as but one part of a bigger picture.

### 5.1. Economic Hedonic part 1: the consumption assumption

Mainstream, "neoclassical" economics (NCE) traces to utilitarianism, but it has undergone significant changes on its way to the "consumption assumption", which equates consumption with quality of life and money with welfare. In Mill's treatise, *Utilitarianism*, he argues that "pleasure,

[10] The designation of a psychological need is not taken lightly; the criteria for qualification as a need are quite strict (Baumeister and Leary, 1995; Sheldon, 2011; Vansteenkiste et al., 2020). For instance, it must "not be derivative of other motives" (Baumeister and Leary, 1995); if it is an outcome of other factors, it is not fundamental. A sense of meaning, emphasized in some eudaimonic approaches, appears to be disqualified on this count; analyses show it to be an outcome, predicted by the three needs. According to Sheldon, a need must be a universal, innate motivator, as well as an experiential requirement for the development of adaptive function and mental health.

and freedom from pain, are the only things desirable as ends" (Mill, 1863, p. 10). However, he takes great care to emphasize that there is a hierarchy of pleasures, at the top of which he places dignity (pp. 11-12). He also states, for instance, that utilitarianism "could only attain its end by the general cultivation of nobleness of character" (p. 14). Bit by bit, however, NCE left that rich philosophy behind. In a wonderful chapter urging a return to virtue ethics in the 2013 WHR (Helliwell et al., 2013, Ch. 5), Jeffrey Sachs (one of the report's lead editors) traces the history of NCE's loss of virtue:

> Mainstream economics in effect lost interest in the state of mind of individuals, and in closely related questions of character, virtue, and happiness. Instead of asking about the economic, social, psychological, and ethical determinants of happiness, economists increasingly focused their attention on the study and explanation of observed consumer behavior. (Sachs, 2013, p. 90)

Many insightful critiques of NCE have elaborated on its flaws and failings, but that is not the focus of this work. To put it briefly, "consumerism not only jostled its place alongside social, psychological, and ethical approaches to happiness, but in the profession of economics and in much public discourse and practice, totally displaced them" (Sachs, 2013, p. 86).

### 5.2. Economic Hedonic part 2: SWB and National Assessments

That being said, more and more economists are rejecting (or at least investigating) the consumption assumption, and there is strong interest in the correlation (or lack thereof) of GDP with SWB. Easterlin (1974) is credited with sparking this trend with his chapter, "*Does economic growth improve the human lot?*". Though GDP's inadequacy as a proxy for WB is by now well-known (e.g., Stiglitz et al., 2009), there continues to be controversy (see Ch. 3 in Jackson, 2016 for discussion). Generally, though, as common sense would suggest, findings support the idea that what matters for life satisfaction is having enough, not having more than that.[11]

Much research has been oriented to identifying the national-level determinants or correlates of SWB. For instance, the World Happiness Report (WHR) is the result of impressive efforts in global polls to find out how happy people are in nations around the world and which conditions

[11] "once a society has reached a certain threshold of development . . . one reaches a point at which further economic growth brings only minimal gains in both life expectancy and in subjective well being. There is still a good deal of cross-national variation, but from this point on non-economic aspects of life become increasingly important influences on how long, and how well, people live. Beyond this point, a rational strategy would be to place increasing emphasis on quality of life concerns, rather than to continue the inflexible pursuit of economic growth as if it were a good in itself" (Inglehart, 1997, pp. 64–65, quoted in Inglehart et al., 2008, p. 266). Personal income as well shows satiation, and in some circumstances, turning points, where beyond satiation, life evaluations *decrease* (Jebb et al., 2018; see also Max-Neef, 1995).

correlate with SWB. It uses 6 other data points to "explain"[12] a large portion of the variation in SWB— 1) the log of GDP per capita[13], 2) healthy life expectancy at birth, and percentages of yes/no answers to whether people: 3) have someone to turn to in times of trouble, 4) are satisfied with their freedom to choose what they do with their life, 5) have given to charity in the last month, and 6) perceive corruption to be widespread in business/government (Helliwell et al., 2020, p. 17).

Fundamentally, surveys like this present observational data that can disprove hypotheses whose predictions are contradicted by the data. The more data are available, the more false theories can be discriminated, narrowing the space of possible explanations. The separate work of hypothesizing explanatory theories remains, but it can be guided and constrained by the data accumulated through survey efforts like the WHR. While there is thus much to be learned from such investigation, the basic methodology has defining features that place limits on its usefulness. A full discussion is quite beyond the scope of this work, but a crucial point to make here is that the observations are *correlative*, meaning that they carry no indications of causality. This approach can show *that* some things do (or do not) seem to go together, in general, but it cannot show *how* they are related or *why* they are (or are not) correlated. The result is that surveys of this type have minimal discriminatory power between different theories predicting similar correlations, even if the theories reflect radically different conceptions of the relationships involved. Thus, while national-level correlative investigations provide solid evidence that higher GDP does not cause higher SWB, and may offer some ad hoc guidance for policy, a coherent theory is still needed.

### 5.3. Economic Eudaimonic

Notable eudaimonic approaches in economics come from economist-philosophers Amartya Sen and Manfred Max-Neef, and the economist/philosopher duo, Doyal and Gough. These scholars take the important step of situating economic concerns as merely one aspect of human WB, and further shift focus from hedonic ideas to activity and capabilities.

#### 5.3.1. Sen and Max-Neef

Sen's "capabilities" approach argues that what matters in societal/economic development is not money or economic growth, but the freedom to achieve functions that people "have reason to value", i.e., their capabilities (Sen, 1999). Sen shows that GDP and capabilities are not necessarily coupled, citing the example of Kerala, which has low economic throughput but high capability, because their institutions prioritize the latter. Max-Neef's (1991) Human-Scale Development

[12] This is a statistical term expressing how much of the variance in the quantity of interest (in this case, "life satisfaction") is captured by the regression model being used. It is not a statement about causality.
[13] The use of a logarithm scale accounts for the diminishing returns.

similarly points to the needs of humans as primary, to which the economic system should be subservient, rather than vice versa. In this model, needs (e.g., for understanding, subsistence, participation) can be satisfied or thwarted in a variety of ways. Both of these theorists place value on the deliberative self-determination of communities, as opposed to exogenous, top-down decrees. For instance, Sen criticizes "the widespread temptation of policy bosses to use fine-tuned 'targeting' (for 'ideal delivery' to a supposedly inert population)" (Sen, 1999, p. 19). Similar to the organismic view outlined below, Sen views people as "active agents of change, rather than as passive recipients" (Sen, 1999, p. 3).

#### 5.3.2. Doyal and Gough's Theory of Human Need

Doyal and Gough's (1991) *A Theory of Human Need* poses two basic needs: health and autonomy (with mental health as a primary component of autonomy). Their theory also poses a set of intermediate needs, i.e., what is necessary to attain the basic needs. In a rare, if brief, recognition of childhood development in WB scholarship, they name "security in childhood" as an intermediate need. Dismissing the false human/nature dichotomy, they posit human needs as ontological realities:

> [needs are not] disconnected from 'human nature', or the physiological and psychological make-up of *Homo sapiens.* To argue for such disconnection would be to identify humanity with no more than human reason and to bifurcate human existence from that of the rest of the animal world. (Doyal and Gough, 1991, pp. 36–37)

In grounding their concept of needs in the human as an organism, they avert the relativism expressed in NCE's flattening of the idea of utility into consumer preferences[14]. However, while Doyal and Gough draw insights from anthropological and psychological literature, their carefully reasoned argument is ultimately philosophical, not empirical, in nature.

#### 5.3.3. EE and Sustainability

Within EE, assessments of WB approaches have often concluded that needs-based approaches offer the best way forward (e.g., Dodds, 1997; Brand-Correa and Steinberger, 2017; Lamb and Steinberger, 2017). However, these approaches tend to be sourced from the above-mentioned

[14] NCE makes no distinction between needs and wants. As Jackson and Marks explain:

> neo-classical economics is almost wilfully silent on the question of human needs, choosing instead to cash out human welfare in terms of preferences, reflected in monetary terms in the market. In economics, as Allen (1982) points out, ''need' is a non-word. Economics can say much which is useful about desires, preferences and demands.... But the assertion of absolute economic need — in contrast to desire, preference and demand — is nonsense''. Some economists have gone even further to suggest that "needs turn out to be mere wants when we inspect them closely.... Do we need water?" Heyne (1983) asks. ''No. The best way to turn a drought into a calamity is to pretend that water is a need.'' (Jackson and Marks, 1999, p. 425)

economist-philosophers and associated works (e.g., Nussbaum, 2011). Several scholars in EE and the wider field of sustainability research have expressed the need to clarify WB; these researchers often note the potential not just for lack of conflict, but for synergy between sustainability (planetary WB) and human WB (Barrington-Leigh, 2017; Helne and Hirvilammi, 2015; Jackson, 2016; Kasser, 2017; Kjell, 2011). Toward such clarity and synergy, the need remains for a conception of human WB with deeper roots than economics can offer: one solidly grounded in the human as a neurobiological organism.

## 6. The Gap: the need for an integrative, consilient theoretical framework

Notably, the vast majority of attention to WB (particularly on the hedonic side) is disconnected from evolutionary and neurobiological knowledge, and in general leaves the sizable literature on psychological development and clinical psychology untapped. Some research borders on this large gap, but it is limited to generating correlative data; a robust explanatory framework is still needed.

### 6.1. Psychology's theory problem

Put bluntly, "Many sub-fields within psychology (though not all!) lack any overarching, integrative general theoretical framework" (Muthukrishna and Henrich, 2019, p. 221). Psychological research features a multitude of "models", isolated from each other and lacking firm grounding in any theoretical foundation (Ryan and Deci, 2017, p. 6). The result is a collection of findings with little organizational structure or predictive value. This free-floating quality is a problem for WB research, as well, and much of Muthukrishna and Henrich's assessment applies to SWB studies. For example, what hypothesis is supported or refuted by the finding that, in survey calls, the harder-to-reach women are slightly less happy, but the harder-to-reach men are slightly more happy (Heffetz and Rabin, 2013)? Even though such findings may be reproduced, they still float free of theoretical underpinnings that would make sense of them.

The lack of theoretical coherence in WB studies also means that various relevant branches of psychology are poorly integrated into those studies' investigations. For instance, there is a paucity of attention to the role of individual development, and evolutionary and neurobiological knowledge seldom informs models of WB.

#### 6.1.1. Ontological prohibitions

This gap can be understood as symptomatic of the basic human-nature rift noted in the previous chapter. The study of humans within the WB literature has generally remained more on the humanities and social science side than on the natural science side. As discussed in the previous chapter, this is understandable if the natural sciences are necessarily reductionistic; attempting to

explain humans within a reductionist framework is a general taboo[15]. Yet this taboo is one of the reasons the actual phenomenon of WB has remained a difficult-to-pin-down concept. When restricted to self-reports, we define WB essentially as "whatever people say it is"—a bit like the definition of intelligence as "what IQ tests measure". This seems, ultimately, an evasive maneuver. The result is that we still don't know what it is we're talking about. It is as if we want to know what makes a car run smoothly, but we are forbidden to look under the hood. According to this taboo (to continue the metaphor), one can look at the price of the car, how wide the roads are, and how much gas it uses, but not at the actual engine or the process of combustion.

In contrast, an ontology that incorporates complex systems understandings is free to acknowledge all that we have learned about the human being without reducing it to a mechanistic assembly of parts or losing it to the groundlessness of relativism. Such a view of the human provides the basis for a coherent theoretical frame for WB—i.e., one that is *consilient*, bridging across the social and natural sciences.

### 6.2. Borders of the Gap

Criticisms aside, the broad and ambitious research programs of SWB are reaching closer to the concerns of eudaimonists, and to the concerns of this thesis. For instance, resonant with the approach taken in these pages, the most recent WHR (Helliwell et al., 2020) features emphasis on the social and natural environments, and spotlights the role of social and institutional trust in the Nordic countries' consistently high levels of life satisfaction. As long ago as 2013, the report featured a chapter (of which Diener was co-author) on the benefits of happiness to health, productivity, and pro-social behavior, even including a nod to evolutionary explanation (De Neve et al., 2013). As regards physical health, SWB does seem to correlate with—and in longitudinal studies, even lead to—better health outcomes (Diener et al., 2017). However, a potential confound is that measures of hedonia (SWB) and eudaimonia (PWB) tend to correlate. In studies that disentangle the two WB measures, it is eudaimonia, not hedonia, that predicts positive health outcomes (Fredrickson et al., 2013; Keyes and Simoes, 2012; Ryff, 2014; Ryff et al., 2004).

[15] Amidst the uproar after E. O. Wilson proposed his Sociobiology, for example, was an event at which demonstrators poured water on his head, chanting, "E. O. Wilson, you can't hide; we charge you with genocide!" The connection is apparently that if one espouses a natural explanation of humans, one is inevitably arguing for genetic, race-based disparities in intelligence or whatever other metric, risking—or even as a ruse for—discrimination, the invocation of eugenics, or the nefarious final solution. In case it is not already clear to the reader, the perspective aimed at in this work is not reductionist, but emphasizes the importance of experience and developmental context for biopsychosocial outcomes. As such, is not amenable to justifications of race-based discrimination, a practice which is clearly contradictory to the aims of well-being.

### 6.2.1. Positive Health and Eudaimonia

On the topic of physical health, Ryff and Singer (1998) express the need to take a biopsychosocial approach, beyond mind-body dualism. Such an approach would consider the common ground and interrelationships between "health" (often considered as absence of physical illness) and "well-being" (often considered as a psychological or emotional phenomenon). The two are not *the same*, as mind and body are not *the same*, but facets of the same whole.

Ryff and Singer call this non-dualistic phenomenon of health and WB "positive health". The central hypothesis of positive health is that "the experience of well-being contributes to the effective functioning of multiple biological systems, which may help keep the organism from succumbing to disease, or, when illness or adversity occurs, may help promote rapid recovery" (Ryff et al., 2004, p. 1383). In their first exposition of this idea, Ryff & Singer (1998) proposed a research agenda for a more comprehensive appreciation of positive health above and beyond a neutral absence of disease. They prescribed a move to appreciating the complexities of mind-body interactions, the centrality of relationships, and the importance of people's motives, appraisals, and reactions to life events. Following up on this agenda 16 years later, Ryff notes that, "Without question, the most informative advances have come from linking psychological well-being to physical health, biological regulation and neuroscience" (Ryff, 2014, p. 23). This thesis is in keeping with her recommendation that these linkages be broadened and deepened.

## 6.3. The Gap Remains

Ryff and colleagues' work is exceptional in that it has investigated and found many correlations between her scales of PWB (particularly personal growth and a sense of purpose in life) and markers of immune, endocrine, and brain function (Ryff, 2014; Ryff et al., 2016). However, Ryff is primarily interested in the health outcomes correlated with high scores of PWB (assumed to demonstrate a direction of influence from mind to body); she therefore does not address the body to mind direction of the dynamic. This thesis addresses the dynamic of mutual influence more fully, focusing on the conditions and processes of *whole-person health*, beyond the dichotomies of mind and body, and well-being and health.

Further, though she and Singer "acknowledge the importance of long-term, developmental perspectives that explicate the distant reach of what happens in childhood" (Ryff and Singer, 1998, p. 19), her interest has always been in mid- to late-life development and ageing (Ryff, 1982, 1975), rather than early developmental processes that would lead to resilient eudaimonic orientations.[16]

[16] In any case, her methods are not suited to that task—an infant cannot fill out a questionnaire to report on its sense of purpose.

This lack of attention to early developmental determinants is widespread in the general WB literature and forms another part of the gap that I address in this thesis. The next section articulates the basic frame and premises of the approach to WB taken in this thesis.

## 7. The Frame: Organismic-Eudaimonic

I have noted the pervasiveness of the ontological rift between humans and nature as a particular challenge for making sense of WB. Some key approaches, however, take the systems view, offering a resolution via a more accurate, up-to-date, and consilient understanding. I here outline some of these approaches in order to synthesize and describe the view that forms the basis of my approach in this thesis. I call this view *organismic-eudaimonic*, because it is grounded in the neurobiological organism as a complex system endowed with innate motives toward growth and integration (organismic) and tracks health and function (eudaimonic) across inter-related modes: physiological, psychological, social, etc. Based on the conclusion that self-regulation is the underlying basis of WB, this thesis focuses on regulatory dynamics as the proximal processes of interest.

### 7.1. Organismic

Organismic approaches take note of some fundamental features of biological organisms as complex systems. Biological systems are open (i.e., they exchange matter, energy, and information with their surroundings), and they are characterized by emergent, hierarchical levels of organization within an overall unity (Jacob, 1973; Kauffman, 2000; Von Bertalanffy, 1968). Living systems have innate tendencies toward growth and self-organization, underlaid by increasing functional differentiation and interconnection of their parts (Maturana and Varela, 1987; Ruiz-Mirazo et al., 2012). This linkage of differentiated parts of the system is referred to as *integration* (Siegel, 2010).

### 7.2. Eudaimonic: interrelated hierarchical domains of functioning

Humans are complex systems, composed of cells (themselves emergent, self-organized living systems), which in relation to other cells form tissues, on up to organs and organ systems. These organ systems (digestive, circulatory, nervous, etc.) are ideally in robust coordination with each other for responding adaptively to varying circumstances. Hierarchical organization within the nervous system in particular gives rise to increasingly integrated kinds of experience. Developmental psychologists Ham and Tronick state it well, noting the interrelation of domains of function and its role in coherence of consciousness (see also figure 1):

> the human being is an open, nonlinear dynamic system consisting of many interrelated

> domains of functioning (physiological, emotional, cognitive/symbolic, and social/behavioral). This system is thought to move toward more complex and coherent states of self-organization as it interfaces with itself and the outer environment. […] As in all complex systems, there are multilayered, hierarchically organized domains of functioning, and each domain is related to and affects the other. A more coherent state of consciousness occurs when ‘‘all’’ domains are organized into greater (but never complete) harmony with other levels. Coherence is a function of organization, complexity, and flexibility in adapting to different environmental conditions. (Ham and Tronick, 2009, pp. 620–621)

The authors go on to emphasize that "in establishing self-organization, others are necessarily involved," noting in particular that infants' self-regulatory capacity is low and that their organization quickly dissipates without external support.

For developmental neurobiologists and psychologists alike, such a systems view is also increasingly the frame, in which the human organism has emergent levels of hierarchical organization whose development is necessarily in relationship to other humans (e.g., Feldman, 2009; Fogel, 2011; Fogel et al., 2007). Beyond these disciplines, two broad meta-theories (both of which take a systems view) inform the approach taken in the present work: self-determination theory and interpersonal neurobiology.

### 7.3. Self-Determination Theory (pt. 2)

As mentioned above, SDT's eudaimonic approach is a theoretically consistent and empirically rigorous social psychology of development, motivation, and WB. Part of what affords its theoretical coherence is that it takes an organismic approach: "Simply stated, individual organisms are endowed with, and energized by, propensities to expand and elaborate themselves in the direction of organized complexity and integrated functioning" (Ryan and Deci, 2017, p. 5). Treating psychology as a life science, SDT situates psychological processes within the broader context of integrative biological processes, seeing the same self-organizing propensity shared by all life at work in the development and experiences of the subjective self. Just as the integrity or breakdown of self-organization and regulatory function yields health or pathology for any life form, the same is true for the human at the psychological level as well. Thus, the degree of successful integration determines psychological outcomes, including WB[17] (see Ryan and Deci, 2017, Ch. 2).

[17] Understanding this self-organization to be the underlying process of WB, the organismic notion of inherent, active developmental striving toward integration can be seen to parallel Aristotle's notion of eudaimonia as *telos*.

Importantly, in SDT, the integration toward which optimal development moves is understood as both inner and outer: psychological and social (Ryan and Deci, 2017). A human is an emergent whole whose full functioning depends on self-regulation at many lower levels of organization, but it is also a part of larger social systems and dynamics. As we shall see in Chapter 5, the degree of social integration strongly impacts the inner dimensions of regulation, as well. (It is important to note that this notion of social integration is not posed within a relativist framework. Given its exposition of basic psychological needs, SDT offers a critical perspective in that different cultures can support need satisfaction to varying degree. Thus, integration into some social contexts will be antagonistic to inner integration. The contexts most supportive of development and WB do not set the two at odds.)

Awareness is key for the process that allows for self-organized, integrated regulation; therefore, mindfulness has emerged as an important topic in SDT research (Deci et al., 2015). Another topic that SDT has recognized as relevant to WB, due to its impact on basic psychological need fulfillment, is non-human nature (Ryan et al., 2010). This thesis has more to say on these topics in later chapters.

Though it is evolutionarily consistent and increasingly interfacing with neuroscience, SDT is still primarily a psychological theory. Though there has been some psychophysiological work in SDT (Bartholomew et al., 2011; Reeve and Tseng, 2011; Weinstein et al., 2019), SDT is still far from fully situating its subject matter in relation to the body. Another meta-theoretically consistent field, discussed next, helps fill in the frame.

### 7.4. Interpersonal Neurobiology

Interpersonal neurobiology (IPNB; Siegel, 2020) is a transdisciplinary synthesis of a variety of fields that give vantage points on the phenomenon of mind, which is understood within IPNB to be an embodied and relational process (Siegel, 2010). Though it, like SDT, acknowledges the importance of relationship to broader nature, IPNB focuses on human relationships, studying the neuroscience of development throughout the lifespan, including therapeutic change and the ongoing experience-dependent plasticity of the brain. Because *attention* directs that plasticity, mindfulness is also an important focus in IPNB's study of what leads to integration, which is understood to be the basis of regulation and WB (Siegel, 2020, 2007).

According to IPNB, a fully integrated, well-regulated human has the properties of a resilient, self-organizing system: it is flexible, adaptive, coherent, energized, and stable (Siegel, 2010). This view agrees with that of SDT: "it is when the organism is integrated, therefore fully self-organized, vital, and coherent, that wellness is in evidence" (Ryan and Deci, 2017, p. 241).

### 7.5. Organismic-Eudaimonic

IPNB and SDT, though based on different lines of study, converge on many important points. Key among them is that integration, or self-organization, is a fundamental aim of complex living systems. A central conclusion of this literature (to be reinforced in the coming chapters) is that integration, and the self-regulation it affords, is the underlying basis of well-being. ***Therefore, this thesis focuses on regulatory dynamics as the primary measure of interest in the organismic-eudaimonic view of human health and well-being.***

## 8. Summary

Though there have been many approaches to the study of WB, the need remains for a consilient theoretical framework. Responding to this need, I approach the whole person as a nested system whose integration, both internally and within the larger system(s), yields WB. Taking a systems view, which emphasizes dynamic relationship with context, this thesis investigates the relevance—in terms of the regulatory dynamics underlying WB—of three fundamental aspects of the human context: the body, other humans, and the "more-than-human" world. (Figure 1 depicts this graphically.)

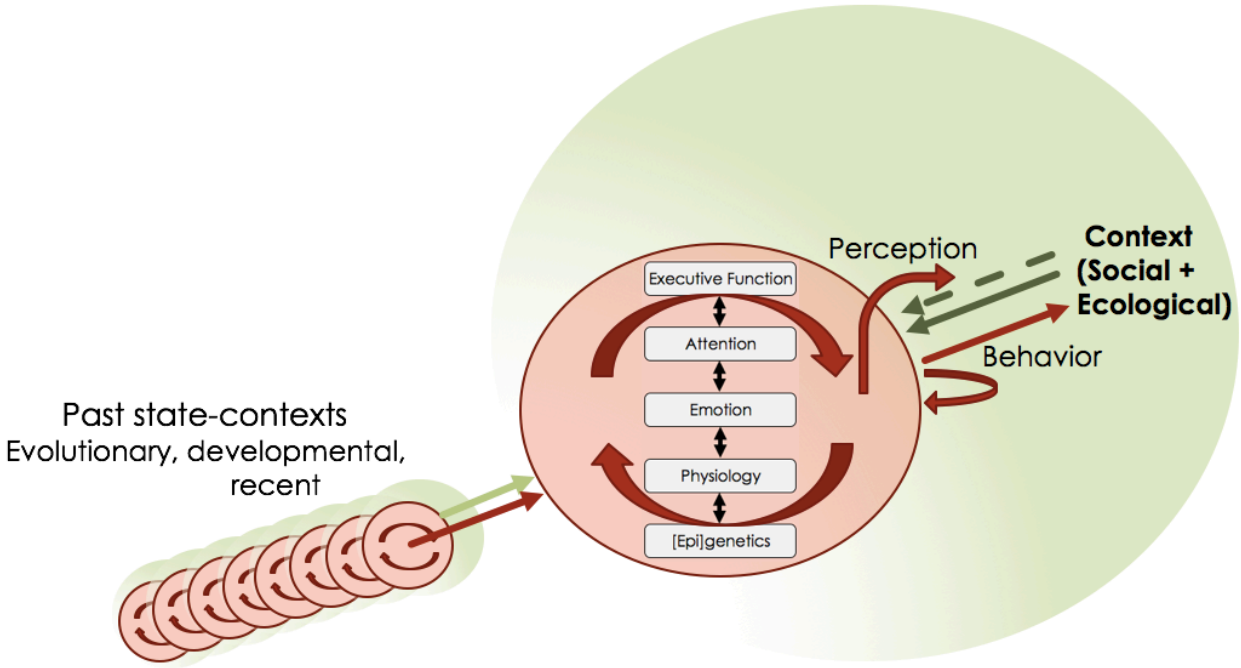


*Figure 1. A schematic of regulatory levels in the human as an organism in process, in relation with itself and its surroundings. Arrows indicate influence. See ch. 4 for elaboration of the regulatory levels (grey rectangles), chs. 4 & 5 for more on the impact of perception.*

# Chapter 3: Methodology

## 1. Overview

The aim of this research is to yield a framework that integrates and makes sense of knowledge from a variety of disciplines, so as to provide a coherent basis for considering the human and well-being (WB). Given the particular demands of this kind of research, Critical Interpretive Synthesis (CIS; Dixon-Woods et al., 2006) provides an appropriate methodological approach. The intention in CIS is not to summarize all of the findings in the literature (a highly impractical task), but rather to generate an explanatory theoretical framework that fits those findings. This is precisely the aim of this thesis.

## 2. Challenges of this kind of research

> Admittedly, positive human health, with its emphasis on complex mind-body processes that must be tracked through time, is a daunting biopsychosocial agenda. Typical "stratigraphic" approaches, which differentiate layers of living into their cultural, social, psychological, and biological components (Geertz, 1973), are not sufficient for the task. The vision required is to go beyond the separated layers into the synthesis of how they come together. (Ryff and Singer, 1998, p. 23)

This thesis aims to bring together ideas and insights from disparate disciplines to create a theoretical framework for considering the human and its health and well-being in the fundamental contexts of the body, other humans, and the non-human world. A project of transdisciplinary synthesis like this one presents a number of challenges not well suited to typical review methodologies. For instance, I have no specific question for which there is quantitative data to aggregate. The relevant literature is wide-ranging and varied: both qualitative and quantitative, theoretical and empirical, correlative and experimental. Additionally, many of the sources I consult in this research are based on models and assumptions that I may be questioning. Thus, for this integrative[18] project, a critical lens is indicated. A standard systematic review cannot respond to these challenges.

## 3. Critical Interpretive Synthesis is well suited to the task

Given the aim of generating theory through synthesis of a variety of concepts and data from

[18] Repko defines this kind of integration as “the cognitive process of critically evaluating disciplinary insights and creating common ground among them to construct a more comprehensive understanding” (Repko, 2012, p. 263).

numerous fields, each with similarly diverse methodologies, Critical Interpretive Synthesis (CIS; Dixon-Woods et al., 2006) is the methodology adopted in this work. CIS is able to integrate qualitative and quantitative data, building on a synthetic method that "involves building up a picture of the whole […] from studies of its parts" (Barnett-Page and Thomas, 2009, p. 2). The intention is not to summarize all of the findings in the literature; given the scope of the present task, such a comprehensive review is not possible or desirable. Instead, the aim is to generate an explanatory theoretical framework that fits—and makes sense of—those findings.

Therefore, in contrast to comprehensive review methods, CIS uses a data collection method called theoretical sampling. Whereas many methodologies dictate a prior delineation of sources to be reviewed, such an approach is not appropriate for this kind of investigation. CIS allows for the reality that relevant data may turn up in unforeseen places and through initially unrecognized connections. The process is thus to choose known, relevant starting points (purposive sampling), then to let the data lead from there in "a constant dialectic process conducted concurrently with theory generation" (Dixon-Woods et al., 2006, p. 4).

From the initial sample, I then proceeded with an eye to relevance and contradiction, keeping the investigation responsive and open to refinement: "Processes of question formulation, searching, selection, data extraction, critique and synthesis are characterised as iterative, interactive, dynamic and recursive rather than as fixed procedures to be accomplished in a pre-defined sequence" (Dixon-Woods et al., 2006, p. 9). In essence, then, through the encounter with the data, my hypotheses were not simply supported or refuted; they were iteratively supported and refuted, undergoing continual evolution in accordance with the data, until further data collection demanded no further adaptation (theoretical saturation). This last stage is perhaps best understood as an ideal, or as a temporary and provisional saturation, since new data is always liable to challenge present conclusions.

This is, in essence, how science generates theory. The scientific method consists of observation, hypothesis formation, experimentation/data collection, and interpretation; this often leads to a change in the hypothesis or update of the model, informing the next experiment, iteratively, with no way to know what the next step will be until the current one is complete and made sense of. The more a hypothesis fails to be refuted or to require amendment to accommodate data (i.e., the more it reaches theoretical saturation), the more it moves toward status as a theory.

## 4. CIS is a young but established methodology

CIS, having originated in the healthcare field in 2006, has steadily grown in application since its

articulation (as evidenced by Google Scholar citations). Many studies have employed this methodology to integrate findings from different research paradigms and to make sense of disparate data. Recently, for instance, researchers used CIS to make sense of the contradictions between brain-based theories of the effects of music on trauma patients on the one hand, and the experiences of music therapists on the other (McFerran et al., 2020). Another study used CIS to integrate knowledge from three different fields in order to inform interventions for the prevention of intergenerational trauma (Isobel et al., 2018). Other researchers employed CIS to assess the relationship between measures of socio-economic status and health disparities (Poirier et al., 2020). Maintaining (as it happens) the emphasis on health, this thesis builds on these precedents.

## 5. Conclusion

Thus, to respond to the need I have identified, a highly synthetic approach was necessary. I did not operate within a theory by doing experiments to deny, update, support, or extend a hypothesis. Rather, using the sense-making methodology of critical interpretive synthesis, I gathered a wide array of data and theories to generate a high-level frame that integrates siloed realms of knowledge, toward a coherent understanding of the basic contextual elements of human life and experience—i.e., our fundamental embeddedness in the body, social relations, and the non-human world. Organized into these three facets of our situation, the next three chapters present the results of this research.

# Chapter 4 – Embodiment

## 1. Introduction

The basic thesis of this chapter is that the quality of the relationship to bodily experience is a core determinant of regulatory function, and thus of health and well-being (WB). In other words, self-sensing is a crucial part of self-regulation, such that poorly calibrated self-sensing is associated with dysregulation and dysfunction (and thus, lower WB). In explaining these connections, I first outline some key neurobiological regulatory systems underlying human function and experience, thus laying the foundation of the organismic-eudaimonic understanding of WB and reinforcing the premise (mentioned in Chapter 2) that self-regulation is the basis of WB. Building on that foundation, I then discuss how the body is experienced, and—central to this thesis—how that experience in turn impacts those neurobiological systems.

*Interoception*, the perception of the internal state of the body, is therefore the central theme of the chapter. The chapter discusses interoception's relation to emotional experience and its regulation, and the role of interoceptive attention in moving from dysregulation to regulation. The chapter finishes with a reflection on the kind of self-sensing most supportive of integrated self-regulatory function, and thus most supportive of WB.

The impacts of this self-sensing are profound. Aberrant interoception has been associated with a wide variety of adverse conditions (Khalsa et al., 2018; Paulus et al., 2019; Quadt et al., 2018), including disordered eating (Martin et al., 2019), obesity (Herbert and Pollatos, 2014), obsessive-compulsive disorder (Stern, 2014), addiction (Verdejo-Garcia et al., 2012), low emotional awareness (Murphy et al., 2018), poor emotion regulation (Füstös et al., 2012), bipolar disorder (Perry et al., 2019), panic, anxiety, depression, and fatigue (Barrett et al., 2016; Harshaw, 2015; Paulus and Stein, 2010; Stephan et al., 2016), borderline personality disorder (Löffler et al., 2018), as well as fibromyalgia (Borg et al., 2015), chronic pain, somatoform disorders (*aka* medically unexplained symptoms, (Ricciardi et al., 2016)), and long term stress (Schultchen et al., 2019). Over the course of the chapter, I highlight the role of dysfunctional or poorly calibrated self-sensing in a variety of different disorders and pathologies, providing a basis for understanding interoception's far-reaching, fundamental role in regulatory function and WB. Through this exploration, it will become clear that if we seek a model of the human that adequately accounts for behavior, development, and well-being, we must include the body.

To set the stage and provide some reference for the exploration ahead, a well-known experiment provides an illustrative starting point.

### 1.1. The Iowa Gambling Task

In the Iowa Gambling Task (IGT; Bechara, 1997), players are given a $2000 loan of fake money and are asked to play so as to make the most money. They can draw from any of four decks of cards: two decks give payouts of $50 but occasionally, unpredictably, yield a penalty of $100, while the other two give payouts of $100 but occasionally have very steep penalties, upwards of $1000. Drawing from the first two decks yields a profit; the other two yield loss. Throughout the game, the players' physiological arousal is measured by monitoring their "skin conductance response" (SCR), that is, subtle changes in electrical resistance in the skin due to fluctuations in the activity of sweat glands. SCR provides a well-established metric of autonomic arousal because sweat production is an involuntary function of the sympathetic nervous system, the fight-or-flight part of the autonomic nervous system (ANS; about which more later). Additionally, the players are periodically asked what is going on in the game and how they feel about it.

Data showed four stages in the course of play. The first stage ("pre-punishment") is the period before any penalties were encountered; players sampled the decks and preferred the high payout decks. When the penalties arrived, they began to show anticipatory SCRs (i.e., leading up to choosing) for both decks, but higher ones for the bad decks. They also began to choose more from the good decks, though they claimed no awareness of any pattern in the decks; thus, stage two is called "pre-hunch". Eventually, while still having no conceptual understanding of the pattern, they moved into the "hunch" stage: for instance, they spoke of "liking" or "disliking" a deck. Most eventually arrived at stage four, conceptual understanding, but even for those who did not, the trend post-penalty is of increasing disparity between the two decks in terms of both anticipatory SCR (which fell for the good deck) and card choice (which fell for the bad deck) (Bechara et al., 2005). That is, adopting the successful strategy was not dependent on conscious knowledge of what the successful strategy was. Even those who never consciously figured out what was happening behaved as if they did.

#### 1.1.1. IGT with frontal lobe damage

Where this experiment gets really interesting, though, is when brain-damaged patients play. Elliot, the pseudonymous representative patient in Antonio Damasio's classic studies of frontal lobe damage (Damasio, 1994), lost his ventromedial prefrontal cortex (vmPFC) due to a tumor. Despite this loss, Elliot's intellect was wholly intact; a battery of intelligence tests showed no abnormality. Further, he could generate a list of potential courses of action in hypothetical social situations and name those actions' probable consequences. Yet, befuddlingly, those capacities failed to inform his decision-making. He was either impulsive or endlessly indecisive, and his life was unraveling because of it. Curiously, however, he was entirely unperturbed emotionally by any of this, or

apparently by anything at all.

His emotional vacancy meant that his SCR profile was abnormal. In pre-IGT assessments, he showed normal SCRs in "startle" conditions. When exposed to emotion-inducing images that reliably spur large SCRs in non-brain-damaged people, however, his readings were flat, even though he could recount the contents of the images, and even describe a normal emotional response, while noting the absence thereof in himself. How did Elliot perform on the IGT? He generated SCRs only upon receiving a large penalty; after each large penalty, though he briefly avoided the bad decks, the effect was quick to wear off. He failed to develop any *anticipatory* SCR, and, correspondingly, he never adopted the advantageous strategy. Like the inverse of the normal players, who behaved appropriately even when they didn't understand the situation, Elliot (like other players with vmPFC damage) continued to preferentially draw from the bad decks, even when he *knew* they were bad decks.

### 1.2. Lessons from the IGT

A main takeaway from the IGT is that conceptual/articulate knowledge is neither necessary nor sufficient for adaptive behavior. Rather, a non-verbal, embodied, not necessarily conscious kind of knowledge is both necessary and sufficient for guiding behavior.

A key aspect of what is happening in the IGT involves the receiving of information about the body's internal state, whether unconscious or conscious. The word used to describe the sensing of the inner conditions of the body is *interoception*[19]. Importantly, though, for that kind of interoceptive information to accrue into functional knowledge, there must be en embodied learning. The brain-body system (i.e., the organism) must be able to associate an action with its response, so as to begin to predict and prepare for likely outcomes. More generally, the organism needs to interpret relevant sensory cues (both internal and external) in context- and goal-appropriate ways, to support adaptive physiological and behavioral regulation. Put simply, past experience informs future forecasts, which guide present behavior.

Whole-brain players quickly, naturally, and initially unconsciously associate the stimulus/action pathway (choosing from deck A) with the resulting somatic experience (big SCR), such that whenever they consider that pathway, the body *predictively generates* the implicitly expected bodily experience again, warning against that course of action[20,21]. Without that

[19] i.e., as distinct from exteroception (sensing the outside world: sight, sound, etc.) and proprioception (relating to the spatial orientation of the body in relation to itself/the world: receptors in joints, muscle, vestibular system).
[20] Damasio calls this the "body loop". Another option is to *simulate* the experience, but just using memory/imagination: this "as-if loop" bypasses the actual bodily activation. See section 2.1.
[21] A more recent review specifies that whereas the amygdala is apparently crucial for that implicit learning, the vmPFC is crucial for generating the anticipatory bodily experience to guide decision-making (Gupta et al., 2011).

embodied predictive model, past experience is unable to inform present behavior—even though it may inform present knowledge!

Navigating the world as an embodied creature requires more than making simple decisions on multiple-choice tasks. It requires using limited sensory data to make sense of one's self, the world, and the interactions between them, in order to manage complex psychophysiological systems for the achievement of a wide array of (sometimes conflicting) goals. The next section provides an overview of these systems and their management. Since (as discussed in Chapter 2 and as the coming pages will emphasize) self-regulation is understood to be the basis of well-being (WB), understanding the systems involved forms the foundation of the organismic-eudaimonic approach's conceptual framework.

## 2. Self-Regulation & Psychophysiology

Humans are inheritors of an incredibly complex and tightly coordinated set of systems and strategies for managing the internal conditions of the body in relation to changing environmental circumstances. Orienting attention and motivation to finding food when hungry, then salivating at the smell of it; sweating when hot, or moving to the shade; releasing hormones that change blood flow and metabolism in situations of perceived danger, preparing the body to flee or fight; not eating a cookie that looks delicious; mounting an immune response to a threat, whether it is microbial or psychosocial; refraining from showing contempt for your boss—all of these are examples of self-regulation.

I draw from Blair and colleagues (2016, p. 3) in defining self-regulation as the conscious or unconscious goal-directed management[22] of physiological, emotional, cognitive, attentional, and overt behavioral responses to internal and external stimuli. This self-regulation involves highly complex interrelationships between many different structures, processes, and aspects of experience. Figure 2 shows a deeply simplified schematic of hierarchical relations of mutual influence (both "top-down" and "bottom-up") between different levels of regulatory activity.

### 2.1. Homeostasis and Allostasis: Self-regulation is both reactive and predictive[23]

Regulatory adjustments are happening all the time in a number of physiological dimensions, systems, and scales. The traditional name for this regulatory activity is *homeostasis*: maintaining

[22] That is, the goal and/or the management can be conscious or unconscious (Custers and Aarts, 2010). As explained later, goals here are understood to be organismic/evolutionary [e.g., for survival], as well as personal. Further, various goals can be in conflict (Cavallo and Fitzsimons, 2012); thus self-regulation also entails mediating and prioritizing among competing aims.

[23] For this section I am indebted to Corcoran & Hohwy (2018) for their very helpful and lucid chapter critically reviewing the divergent uses of the term allostasis in the literature.

physiological variables (e.g., of temperature, blood pressure, glucose levels, etc.) within ranges suitable to life/survival (Cannon, 1929). All living things must do this if they are to remain living. Additionally, though homeostasis has been variously construed over the years, it traditionally included the shifting of those ranges in response to threats to survival; i.e., a temporary divergence from baseline so that baseline can continue (e.g., Richter 1924). If resources weren't rallied to escape a predator, there'd be no baseline to return *to*!

Recently, however, some theorists have argued that the concept of homeostasis is inadequate for explaining the predictive, preparatory (i.e., not just reactive) aspects of how humans and other brainy animals[24] regulate their internal milieus in relation to their worlds (Schulkin and Sterling, 2019; Sterling, 2012). Allostasis, initially proposed by Sterling and Eyer (1988) as "stability through change", specifically countered the notion of a purely reactive homeostasis. The term has recently caught on, but usage is not uniform (Corcoran and Hohwy, 2018; Ramsay and Woods, 2014).

In this thesis, I treat homeostasis and allostasis as on a continuum, with allostasis as a sort of extension of homeostasis into the future, allowing more and more elaborate "top-down" regulation based on learning, prediction, and goals. The homeostatic end starts with unconscious physiological reflexes that don't enter into consciousness (Ceunen et al., 2016). Some small distance toward allostasis, there are inherited behavioral responses to species-relevant stimuli. That is, some stimuli are evolutionarily important enough to the species that their meaning need not be learned; the responses are innate. These are sometimes called "unconditioned stimuli" (US), like the smell of a predator for a rat, or a painful shock.

Somewhere in the middle of the continuum, a US can be tied to an otherwise neutral stimulus, like a bell, through associational learning. The bell in this case would be called the conditioned stimulus (CS). If a bell is reliably predictive of food, as with Pavlov's famous dogs, it (the CS) will prompt salivation even in the absence of the food itself (the US). That same bell, if reliably predictive of a shock, will prompt the secretion of defensive hormones. (As we've seen, autonomic activation may be prompted by the simple act of reaching for a deck of cards.) These kinds of allostatic responses orient attention and organize physiology (Berntson et al., 2016a) in preparation for behavior that is expected by the organism to be adaptive for its perceived situation.

Past experiences and associations inform working models of the world, ourselves, and the interactions between them. Based on these models, we can predict and tinker with what hasn't yet

[24] Though see also (Calvo and Friston, 2017) for an account of the complex regulatory behaviors of plants.

happened, mapping the divergent outcomes that may result from different courses of our own action. In this "counterfactual" way, we imagine "increasingly distal outcome states and the behavioral policies that would lead towards their accomplishment" (Corcoran and Hohwy, 2018, p. 286; cf. Piaget's formal operational stage of cognitive development: Inhelder and Piaget, 1958). This can potentially result in conscious goal-oriented, top-down organization of physiology, attention, motivation, and behavior. This conscious regulation is a key element of *executive function* (see Fig. 2), which is the purview of the prefrontal cortex (PFC). This PFC-dependent executive function is most closely associated with the "experiencer-agent" we identify with: the self who is aware and makes choices (Smith, 2017). The span of its awareness of and access to the broader organismic self (its reactions, motives, etc.) is a primary determinant of integration (Smith et al., 2018). That is, self-sensing has a lot to do with regulation and WB; e.g., how "in control" we feel of ourselves (Seth et al., 2012). As noted by trauma expert Bessel van der Kolk, agency starts with interoception: "the greater that [interoceptive] awareness, the greater our potential to control our lives" (Van der Kolk, 2015, p. 99).

The upper allostatic end of regulation, characteristic of executive function, is more flexible and able to plan further into the future (as compared with regulation orchestrated by lower levels)—but it is also less automatic and more precarious. For instance, as lower-level activation increases, the higher-level regulation becomes less available (Arnsten, 2009; Liston et al., 2009). This means that behavior becomes more rigid, reactive, and habitual. As will be reiterated, the robustness of the high end allostatic regulation (executive function) depends crucially on how successfully the individual has traversed developmental pathways (Beauchaine and Cicchetti, 2019; Blair et al., 2016).

One additional use of the term allostasis needs mentioning. Frequent or chronic defensive divergence from homeostatic baseline results in increased wear and tear on the organism and, potentially, persistent dysfunction and pathology (McEwen, 1998). Associating allostasis with the mid-level defensive (rather than the high-level executive) function, McEwen and Stellar (1993) coined the terms "allostatic load" and "allostatic overload" to denote this cumulative cost. These dynamics have particular importance for WB; therefore, the rest of this section outlines some of the systems that mediate these homeostatic and allostatic processes, beginning with an overview of the primary systems of arousal and defensive activation.

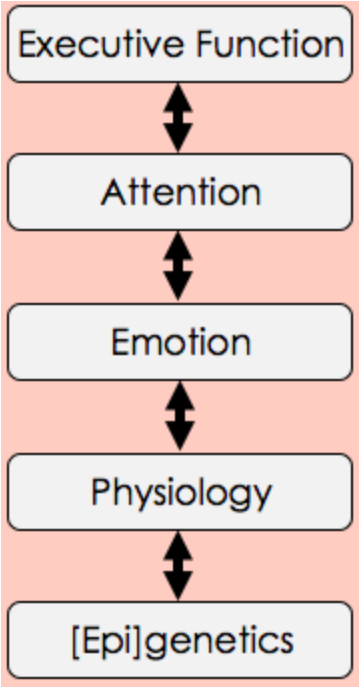


*Figure 2. Simplified depiction of self-regulation as a hierarchy. Executive function (e.g., flexibly directing attention and action toward goals in the face of competing impulses) depends on the prefrontal cortex (PFC). Attention will be discussed more in sections 3 and 5; see section 4 for more on emotion. Sections 2.2 and 2.3 address physiological regulation. Epigenetics refers to changes in gene regulation and expression. Overt (outward) behavioral outcomes of these dynamics are not depicted. Based on Blair et al. 2016, p.3.*

### 2.2. Physiological regulatory systems: Arousal/Defense

To understand the links between mind and body, and their relevance for WB, we must review some of the physiological systems that are our inheritance, conserved and extended over evolutionary lineages. One major aspect of regulation is arousal, which is initiated by the limbic system and the sympathetic nervous system, with important roles for hormonal and immune systems. The prefrontal cortex (PFC) must be involved to maintain healthy regulation of this system. We will see later how the way we relate to bodily experience is involved in these dynamics. Here, we will survey the systems responsible for defense and arousal before discussing safety and passivity.

#### 2.2.1. Limbic system

The limbic system coordinates automatic arousal.[25] It sits between the cortex of the brain and the brainstem, and is thus termed "subcortical". The region that this chapter highlights is the

[25] The notion of a limbic system is widely utilized because it is a handy schematic; however, like many attempts to divide a whole into chunks, it comes with its own set of problems. For instance, following Paul MacLean's (1990) division of the brain into neomammalian cortex, paleomammalian limbic, and paleo reptilian brainstem, the limbic system is generally seen as the engine of emotion. However, we've already seen that the vmPFC's action (by driving lower structures) is required for human emotion. It's thus no wonder early neuroscience giant Nauta (1971) classified the vmPFC as an honorary member of the limbic system, due to its dense subcortical interconnections.

*amygdala*;[26] it plays an important role in learning what warrants a defensive response, and in coordinating that response via the systems described below. Crucially, arousal/stress beyond intermediate levels translates to more automaticity in the response, undermining higher-level regulatory function (Blair et al., 2016). The next subsection addresses the dynamics of the amygdala and the involvement of the prefrontal cortex in its inhibition.

#### 2.2.1.1. Associational learning, allostasis, and the amygdala

As alluded to in section 2.1, the sound of a bell can come to predict, via associational learning, some subsequent event. The brain orchestrates the organism's preparation for the expected situation in part by allostatically adjusting or overriding homeostatic ranges. For example, if the bell has come to be associated with impending food, then the conditioned response might include salivation, whereas if the bell has come to signify an impending shock, the response might include release of defensive hormones. In the case of shock, the amygdala is involved in what is called fear learning. New experience of unpaired bell can stimulate learning of a lack of meaning: in the case of shock de-association, this updating of the predictive model is known as fear extinction. Once bitten, twice shy, but forever shy without extinction. This extinction of fear response is not forgetting the prior association; rather, it is adding nuance and context, getting more specific about what precisely ought to cue a defensive response (LeDoux, 2015). That is, it updates the model based on new data. This process of "safety learning" is mediated by a different neural pathway than that of fear learning. Crucially, it depends on the medial regions of the prefrontal cortex (mPFC), which inhibit the amygdala activation. This is part of a broader pattern of the PFC's regulatory role in relation to limbic structures (Brosschot et al., 2018; Heatherton and Wagner, 2011).

The amygdala receives preconscious, priority access to sensory information from the thalamus (sensory relay center), before (and whether or not) it reaches the PFC. LeDoux (1998) calls these sensory paths the low road and the high road. The low road is quick but crude; it can rally bodily and behavioral responses rapidly and without deliberation, in support of survival. Clearly, this has evolutionary benefit. Yet without the more detailed high road, the associational cues on which the limbic system is basing its response (i.e., the predictive model) can remain rigid and poorly attuned to actual circumstances. An overgeneral association amounts to a maladaptive hypervigilance that narrows behavioral repertoire and (if frequent or chronic) dysregulates

[26] In fact, like most structures in the human brain, there is one in each hemisphere, with somewhat different functions not important for our purposes here. Further, there are subregions of the amygdala with functional distinctions that are, for simplicity's sake, not addressed here.

physiological systems (Brosschot et al., 2018).

In contrast to the habitual reactivity of the amygdala circuit, PFC regulatory pathways allow for more creative and flexible responses to stressful situations. However, to note the typical complexity: by exciting the amygdala and weakening the involvement of the PFC, stress enhances fear learning and inhibits fear extinction, yielding increased automaticity (Sapolsky, 2017, pp. 129–130). This is an example of a regulatory dynamic with its own momentum, stability, or *resilience*, in which the very thing that is needed in order to break out of the cycle is made less accessible by the cycle itself. In this case, the regulatory mode is less integrated, since the PFC is not functionally linked.

Addressed next are the systems by which the amygdala/limbic system rallies the body's responses.

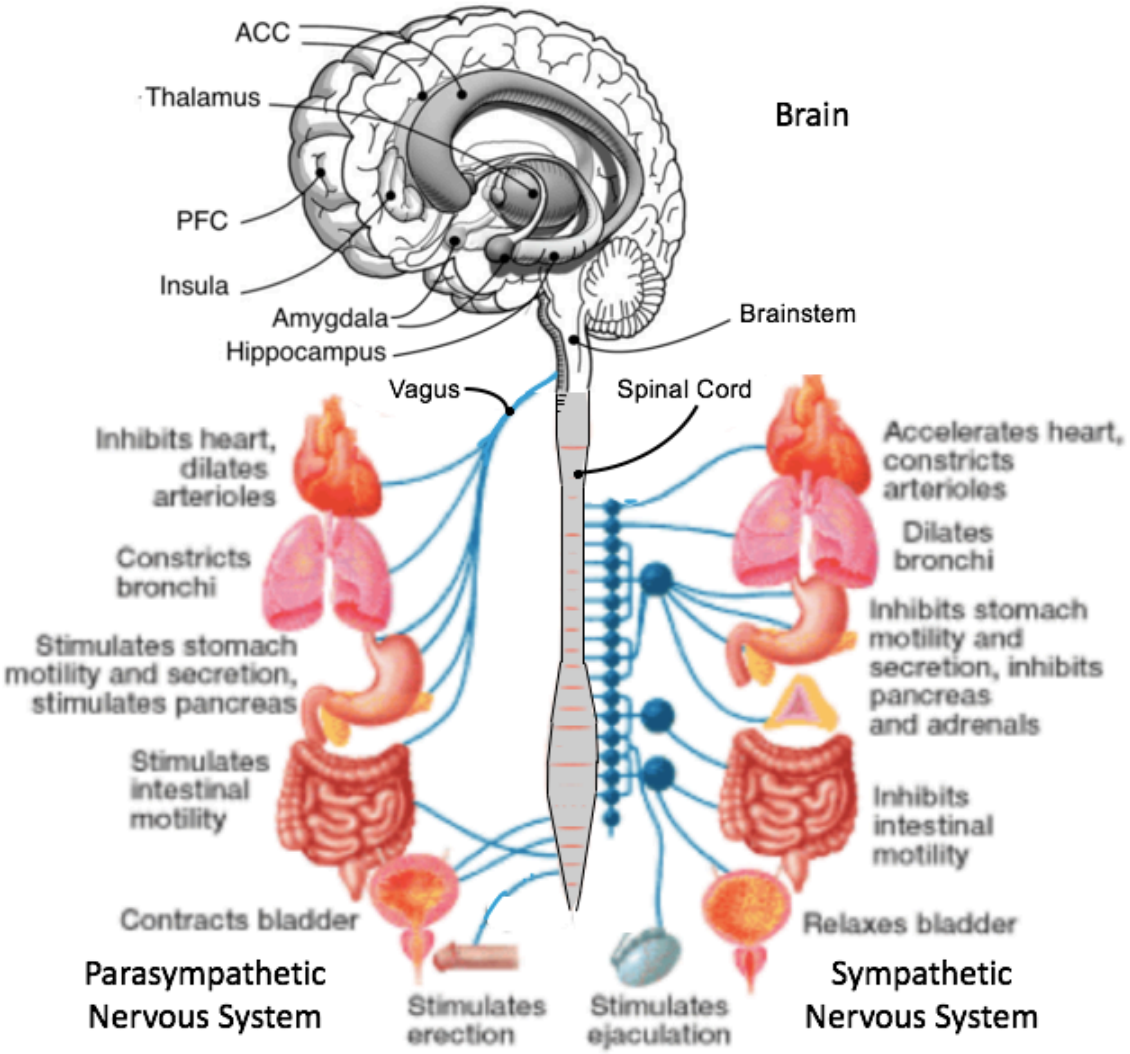


*Figure 3. A diagram of the brain and spinal cord, depicting main aspects and basic actions of the two branches of the autonomic nervous system. The brain is shown with much of the left half removed. PFC, prefrontal cortex. ACC, anterior cingulate cortex (a major component of the medial PFC). (Adapted from Morris & Maisto, 2001, p. 72; and Siegel, 2012, p. 156. Not to scale.)*

### 2.2.2. Sympathetic Nervous System

The most well-known of the arousal systems is the sympathetic nervous system (SNS), responsible for the "flight/fight" response. It impacts organs through direct innervation as well as through the release of adrenaline (*aka* epinephrine) into the bloodstream from the medulla of the adrenal gland (ad-renal = next to the kidney). The other hormone/neurotransmitter involved with this system is noradrenaline (*aka* norepinephrine). Influences of this system on the body promote active response to challenges or danger. SNS activity increases heart rate, blood pressure, sweat, blood flow to skeletal muscle (while decreasing blood flow to the digestive system). These actions are examples of arousal's support of catabolic processes (breaking down to get and expend energy), opposing anabolic processes (building and repairing).

### 2.2.3. HPA axis

Another primary channel of the stress/arousal response is the HPA axis. HPA stands for "hypothalamic-pituitary-adrenal cortical": the hypothalamus (part of the limbic system, located below the thalamus in the brain) signals to the pituitary gland to release a hormone into the bloodstream, prompting the release of stress hormones called glucocorticoids (GC; mostly cortisol in humans) from the outer layer of the adrenal gland, the gland's cortex (as opposed to its adrenaline-releasing medulla). As with the SNS, effects of HPA are catabolic, mobilizing and utilizing resources, and GC level is a widely used measure of stress response. When the HPA axis is well-regulated, GC dampens HPA activity at the hypothalamus and pituitary, acting as negative feedback that keeps GC levels in check. However, frequent or chronic activation leads to allostatic load, not only because of sustained increased catabolism, but also because of effects on signaling in other systems, breakdown of healthy brain dynamics, and a host of systemic effects.

For glucocorticoids, as for many things physiological, too much or too little leads to poor functioning; its health benefits as a function of exposure are described roughly by an inverted-U, where intermediate levels yield the best outcomes. Highlighting the complexity of these systems, however, GC impacts in the brain depend in part on whether or not the amygdala is activated—for example, GC in support of the arousal and catabolism of exercise yields growth rather than atrophy of neuronal connections in the hippocampus [memory center] (Sapolsky, 2017, p. 144).

### 2.2.4. Neuroimmune axis: Inflammation

The function of the immune system is to protect against invasion by harmful entities, and to support the removal and repair of damaged tissue (Daruna, 2012). One of its primary actions is to administer inflammation through the production by immune cells of a wide variety of molecules, including proteins called cytokines, both pro- and anti-inflammatory. Inflammation can be

mounted locally, in response to tissue damage, or systemically, in response to infection. Even simply perceiving disease cues can lead to increased immune activity (Murray et al., 2019). Importantly, inflammation can also result from psychosocial stress, and many immune products are used as biomarkers of stress. Thus, a persistent psychological source of stress, e.g., general defensive orientation, anxiety, or obsessive thinking, can spur the immune system to maintain inflammation (Renna et al., 2020), incurring allostatic costs described below.

As with many brain-body systems, though, this influence is not unilateral but mutual. The brain was once thought to be "immune-privileged" by virtue of the blood-brain-barrier. However, there are places where that barrier is more permeable, such that various immune signaling can pass from blood to brain, carrying a variety of consequences. This immune activity impacts processes of learning, memory, and neuroplasticity (Yirmiya and Goshen, 2011) as well as mood and behavior (Wohleb et al., 2015), changing reward-center dynamics in the brain (Harrison et al., 2016) and facilitating "sickness behaviors" (e.g., fatigue, anhedonia), which over time are implicated in depression and neurodegeneration (Savitz and Harrison, 2018).

Chronic inflammation is also implicated in numerous physiological ills, including cardiovascular disease, stroke, diabetes, osteoporosis, autoimmune disease, chronic kidney disease, non-alcoholic fatty liver disease, various kinds of cancer, and generally accelerated aging (Ferrucci and Fabbri, 2018; Furman et al., 2019; Piber et al., 2019). According to the Global Burden of Disease report, over half of all human deaths are attributable to inflammation-related diseases (GBD 2017). Thus, broadly speaking, immune activity's relationship to organismic health and function also follows the inverted-U pattern: too little, and we succumb to infectious diseases; too much, and we succumb to non-infectious and auto-immune diseases.

#### 2.2.5. Interactions and temporality

Intermediate or transient levels of (HPA-released) glucocorticoids act on immune cells to yield an anti-inflammatory effect, but with chronic glucocorticoid exposure those cells can develop glucocorticoid receptor resistance (GCR; Cohen et al., 2012). This weakening of an important regulatory negative feedback means that inflammation is more likely to continue unabated. SNS activation can also prompt (via changes in gene regulation) the production of immune cells biased toward GCR and pro-inflammatory cytokine production (Savitz and Harrison, 2018).

It bears mentioning that descriptions of these systems and interactions are necessarily presented in very simplified form. The full story is exceedingly complex, beyond current scientific

knowledge.[27] However, this basic treatment is enough to build on for our purposes. We next turn to the remaining branch of the autonomic nervous system.

### 2.3. Parasympathetic Nervous System

The complement of the SNS's "flight or fight" is the parasympathetic nervous system (PNS)'s "rest and digest": whereas arousal and activation prime catabolic processes for short-term survival/performance, the PNS supports anabolic processes of healing and growth. Where the SNS is often associated with situations of danger, the PNS is generally associated with safety (though as we'll see below, it is also associated with life threat.) Though the two branches of the ANS were once considered to be antagonists, in healthy regulation, they can coordinate flexibly in nuanced and organ-specific ways (Berntson et al., 2008; Morrison, 2001). For instance, in the "dive reflex" (e.g., when under water), the SNS constricts blood vessels not only in the viscera, but in skeletal muscle, too, prioritizing blood and oxygen supply for the brain and heart. At the same time, the PNS slows heart rate. This combination keeps blood pressure constant even in the context of near total vasoconstriction (Dampney, 2016).

The primary component of the PNS is the vagus nerve[28], the tenth cranial nerve (originating from the brainstem, as opposed to the spinal cord-sourced sympathetic and peripheral nervous systems). As we'll see below, the vagus plays a starring role in the story of interoception: more than 80% of the vagus is sensory, relaying information from the viscera to the brainstem (Berthoud and Neuhuber, 2000). The vagus is organized into two branches. The unmyelinated[29] "dorsal" aspect relays with the viscera primarily below the diaphragm and plays an important role in the neuroimmune axis and anti-inflammation (Thayer and Sternberg, 2010). The myelinated "ventral"

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[27] Some small examples: There are actually numerous intervening steps and hormonal interactions in the HPA axis (Herman et al., 2016). The precise effects of adrenaline and noradrenaline are dependent on fluctuating levels of different kinds of receptors, with sometimes opposing effects, e.g., vasodilation vs. vasoconstriction (Light, 2007). Bones produce a hormone called osteocalcin that can produce an acute stress response even in the absence of adrenaline (Berger et al., 2019). Skeletal muscles are also endocrine and immune organs, which upon contraction produce anti-inflammatory proteins called myokines and cytokines (Furman et al., 2019).

[28] Other cranial nerves are also classified as parasympathetic (Butler & Hodos 2005, Chs.10-12 on cranial nerves), and many of these are in close association/proximity/coordination with the ventral vagus, but they don't go beyond the throat.

Beyond the cranial and "thoracolumbar" (sympathetic, emerging from the thoracic and lumbar regions of the spine), there is also the sacral autonomic, originating from the sacrum, at the bottom of the spinal cord. The sacral autonomic has traditionally been classified as parasympathetic. It picks up where the vagus ends, innervating the colorectal and urogenital regions. Based on ontogenetics/embryologic development, a recent high-profile paper created an uproar in that small corner of the field by declaring the sacral autonomic to be sympathetic (Espinosa-Medina et al., 2016). In a response paper, one researcher says that the distinction is and has always been functional, not ontogenetic (Neuhuber et al., 2017), prompting the original lab to give something of a history lesson (Espinosa-Medina et al., 2018). At this point, an authority in the field entered to give the final word: the sacral is functionally parasympathetic (Jänig et al., 2018). In any case, the sacral autonomic will be ignored for the rest of this thesis.

[29] Myelination refers to the insulating myelin sheath around the axons of the neurons, which allows neural signals to transmit up to 300 times faster (Purves et al., 2001).

aspect relays with organs above the diaphragm. Importantly, as we next review, the ventral vagus is intimately involved with the control of the heart.[30]

### 2.3.1. Heart Rate Variability

The interval between beats of the heart is not static in a healthy human at rest, but rather has rhythmic oscillations, at both low and high frequencies. The high frequency rhythm of heart rate variability is tied to the breath, and is thus sometimes referred to as respiratory sinus arrhythmia (RSA). This is the rhythmic variability of interest in this discussion; this thesis will follow many others in referring to it simply as HRV (heart rate variability) or "vagal tone".[31] The proximate source of this tightly coordinated cardiac control is the myelinated ventral vagus, with its rapidly conducted signal.

To simplify, the intrinsic pacemaker of the heart fires at around 80 beats per minute; however, resting heart rate is usually slower than that because of the inhibitory influence of the vagus. On the inhale, however, that inhibition is lessened, leading to a transient increase in heart rate, followed on the exhale by a transient decrease. Thus, the amplitude of HRV is regarded as a measure of parasympathetic influence (Berntson et al., 2016b).

However, as discussed further below, this PNS-influence requires the prefrontal cortex's "top-down" regulation of the subcortical structures (e.g., amygdala) that prompt defensive autonomic/endocrine responses (see previous section). Thus HRV is also theorized to indicate the strength of the network of autonomic coordination along the neural axis of brain and body, called the central autonomic network (CAN; Benarroch, 1993; Sklerov et al., 2019; Thayer and Lane, 2009). In support of this connection, HRV has been found to correlate with activity in the CAN (Jennings et al., 2016; Winkelmann et al., 2017)—most importantly, in the inhibitory prefrontal-subcortical connections (Thayer et al., 2012). Therefore, we would expect HRV to predict enhanced safety learning/fear extinction, which indeed it does (Pappens et al., 2014).

Given the many implications of this PFC-PNS co-activity for regulation of brain and body, we should not be surprised to learn that numerous studies find HRV—i.e., as an index of vagal tone—to correlate with many aspects of physical and mental health (Mulcahy et al., 2019), including inflammation (Williams et al., 2019), cardiovascular disease (Thayer and Lane, 2007), cortisol and glucose regulation (Thayer and Sternberg, 2006), as well as emotion regulation (Williams et al., 2015) and executive function (Thayer et al., 2009).

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[30] The dorsal vagus also innervates the heart, but serves different purposes (Gourine et al., 2016). Though it makes up roughly 70% of the total vagal neurons, it provides only 20% of cardiac projections (Taylor et al., 2014).

[31] As with muscle tone, "tone" here denotes baseline activity. The higher the vagal tone, the higher the HRV.

### 2.3.2. Passive defense

The PNS is also involved in *passive* defense strategies. Where the SNS's active defense occurs in situations of escapable danger, involuntary responses of immobility or collapse occur when threat is perceived as inescapable (e.g., when in the grip of a predator). "Playing dead" can be an effective survival strategy, as for the gazelle that falls limp when captured by a lion but is able to rouse and escape moments later, or for the stiff immobile rat that looks unappealing, as if *rigor mortis* has already set in (Kozlowska et al., 2015). However, as with the active modes of defense, a crude predictive model (e.g., as in learned helplessness) can lead to this strategy being triggered in circumstances where other options would be more adaptive. In humans, passive defense can show up as dissociation, excessive compliance ("appeasing"), and even fainting (Lanius et al., 2014; Van der Kolk, 2015). Further, humans seem to have more trouble recovering from these states than do other animals, resulting in lasting dysregulation, both psychologically and physiologically (Scaer, 2014).

As mentioned above, when limbic structures override executive function, there is less agency as behavior becomes more reactive and habitual; the regulatory mode is less integrated. In passive defense, this loss of integration is exaggerated. Whereas the PNS physiology of safety is associated with the integrated function of the PFC, in collapse, a region in the upper part of the brainstem[32,33] takes over (cf. Maren, 2007), and higher regions "go dark" in brain imaging scans (e.g., Van der Kolk, 2015, p. 71). With this loss of integration in the brain come disruptions in sensory processing and in the sense of self, profound disconnection from the body, and an accompanying loss of agency and presence (Lanius et al., 2014; Seth et al., 2012). That is, less integration yields lower WB.

## 2.4. Self-regulatory systems summary

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[32] I am referring to the periaqueductal gray (PAG), which is intimately involved with the "defense cascade"—i.e., as threat moves from potential to inescapable. E.g., the dorsolateral aspect (dlPAG) is involved with exteroceptive orienting to cues of potential threat (Dampney et al., 2013); stimulation of the front and back parts of the dorsal section triggers fight and flight, respectively; the ventrolateral (vlPAG) orchestrates collapse (Keay and Bandler, 2015). In active defense, non-opioid analgesics allow attention to stay sharply focused on threat-relevant matters without getting distracted by injury. In passive defense, HPA activity is down-regulated, and endogenous opioids cause anaesthesia, i.e., reduced self-sensing. The vlPAG has strong connections to the brain region involved in placing the body in space (temporoparietal junction, TPJ), which can cause out-of-body experiences.

[33] A further note for readers expecting mention of the widely cited polyvagal theory (PVT, Porges, 2011): While it popularized (particularly among trauma therapists) the notion of distinct modes for safety, active defense, and passive defense, its attribution of the passive mode to the activity of the dorsal vagus has been discredited by careful research. The vlPAG projects to the ventral vagus, not the dorsal (Koba et al., 2016), and the dorsal vagus does not control heart rate (Cheng et al., 2004; Gourine et al., 2016). Further, though it is claimed that "only mammals have a myelinated vagus" (Porges, 2011, p. 55), vagal myelination is in fact widespread throughout vertebrate groups (Taylor et al., 2014). However, the idea of the ventral vagus as associated (at least in humans) with a "social engagement system" is consistent with a broad literature, and is thus included in the next chapter.

This section has emphasized the interrelation of different regulatory systems, as well as their different modes of coordination in safety and defense, providing evidence that integrated functioning is key for WB. The connection of PNS to PFC via the CAN, as highlighted by studies of HRV, further emphasizes the interrelation of different regulatory levels (see Fig. 2). Having reviewed some basics of self-regulation, we now discuss some of the dynamics of perception and self-sensing, which play central and powerful roles in the regulation and WB of the organism as a whole.

## 3. The Lived Body: Neurobiology of experience

Though we may assume that sensory signals flow "bottom-up" from sensory organs at the periphery of the nervous system to faithfully represent stimuli in the brain, such a view misses the two-way dynamics and predictive nature of perception.[34] The most recent, neuroanatomically sophisticated model of perception is that of *predictive processing* (PP; Clark, 2015; Walsh et al., 2020), describing how past experience, current expectations, and our own actions shape perception in a "top-down" manner, as well. Due to its explanatory power and parsimony, PP has been applied in recent years to a growing number of neuroscience arenas (Hohwy, 2020; Hutchinson and Barrett, 2019). It likewise forms part of the theoretical frame of this thesis. Therefore, this section begins with a discussion of the general processes of sensory perception as described by predictive processing. After this overview, we explore how these dynamics apply to interoception, discussing consequences for self-regulation and WB.

### 3.1. Predictive Processing: Perception is predictive

One of the basic ideas of PP is that sensory signals are effects that give clues from which we can only *infer* the causal origin, i.e., the actual thing that is the subject of our sensory input. We/our brains seek to make sense of[35] the sensory information we receive by modeling potential causes and making predictions of what will happen next based on those implicit hypotheses (Clark, 2015). Those predictions, or "priors", and the sensory input they encounter, are compared and weighed against each other in terms of their respective, context-specific "precision", or probability of accuracy, yielding a "posterior", which becomes the prior for the next iteration (see Fig. 4).[36] If

[34] One commonly recognized example of this influence is how the smooth gradients of vocal sounds are shaped into categories specific to one's native tongue (Pons et al., 2009). The l/r distinction of English is not made in Japanese, for instance, such that the difference is not easily perceived by a monolingual Japanese-speaker, though the same air pressure waves reach the eardrum.

[35] Or rather, make percepts of (since this process determines what we actually perceive)

[36] An example of "precision-weighting" across sensory modalities occurs when, in the context of white noise (lowering auditory confidence), a "ba" sound is likely to be perceived as a "pa" sound if paired with a puff of air on the skin (Gick and Derrick, 2009).

our predictions (priors) are consistently met with the expected signals, we tend to be fairly confident that our grasp of underlying causes is reliable. If not, the discrepancy between expectation and observation yields a "prediction error" (PE). Thus, in PP, predictions flow down and prediction error (PE) flows up between each hierarchical layer of sensory processing, from the nerves at the sensory periphery through different regions and networks in the brain (for detailed description, see Smith et al., 2017).

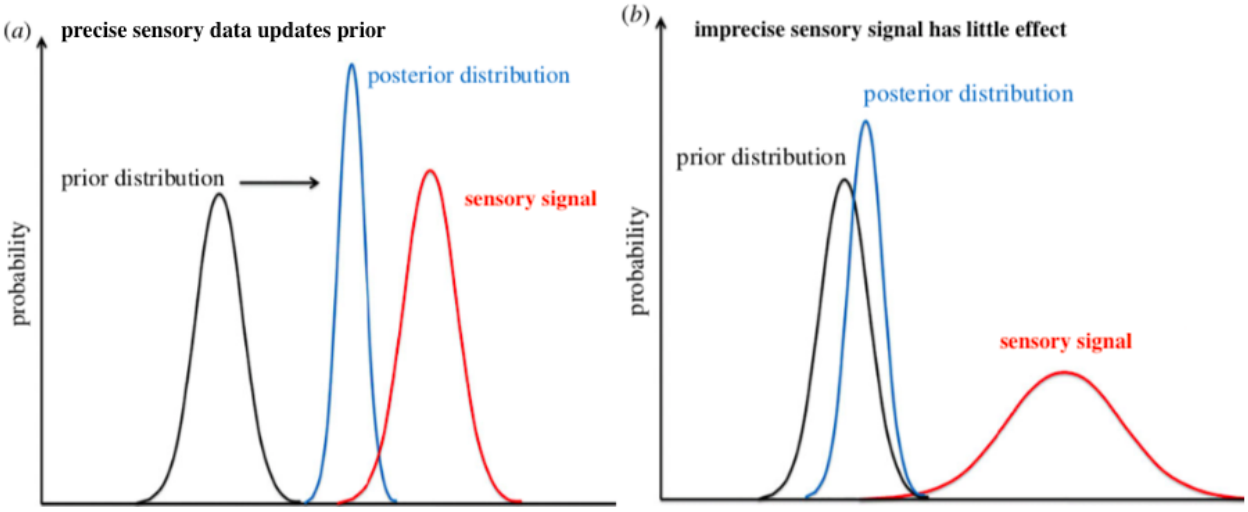


*Figure 4. Probability distributions along the dimension of some hidden state (x-axis), which must be inferred. Relative precision of sensory input and prior determines the posterior. a) A relatively precise signal allows the posterior to shift, whereas b) the update is minimal if the signal is imprecise. (Adapted from Ainley et al., 2016).*

### 3.1.1. PP tries to minimize error

The goal of predictive processes is to minimize PE, averaged over time. PP outlines three basic methods of resolving PE (Barrett and Simmons, 2015). One is to allow the signal to update the model, thereby bringing the prediction more in line with the signal, as in Figure 4a. This is called "perceptual inference". Another method is to seek or create (e.g., through movement) the sensory signals that match the prior; that is, to act in such a way as to bring the signal in line with the prediction. This is called "active inference".[37] The third option of PE minimization basically amounts to ignoring it: confidence in incoming data is turned down, and the top-down (prior) dominates (corresponding to Fig. 4b). That is, the signal is simply construed or categorized as whatever was already expected according to the predictive model, even if the model is a poor fit for the circumstance. This works fine in some situations; however, (as we've seen) if either what

[37] Adding complexity, action can also be used to gather more sensory data ("epistemic foraging"; Friston et al., 2017), as in turning one's head to look, exploring, or experimenting. Also, note that categorization of these methods and usage of terms is not entirely uniform (and often ambiguous) in the literature. In this thesis, I generally follow the usage in (Farb et al., 2015).

is expected or what is misconstrued has regulatory relevance (as for threats), such top-down dominance is maladaptive, leading to regulation that is not well-suited to the situation, and preventing the update of the model. As will be emphasized below, these processes depend on the modulation of attention. For instance, directing attention to sensory input increases its precision, leading to more of an update (Ainley et al., 2016).

Barrett (2017) offers an analogy of the brain as a scientist testing its hypotheses. The scientist may preserve her model by ignoring conflicting information or attributing it to measurement error. Or she can rig the experiment to produce confirmatory results in a biased way, and thus make the data loyal to the model. Alternatively, the scientist can seek to align the model with the incoming signals. Being an embodied agent in dynamic relation to the world, however, is different from the ideal of a dispassionate scientist (Allen and Tsakiris, 2018). PP addresses this by integrating perception with action and self-regulation more broadly. As discussed below, active inference is understood to be the means through which self-regulation is initiated.

#### 3.1.2. Predictive regulation: Priors as goals

In order to appreciate the regulatory importance of priors, a point must be made: Priors are not simply predictions of expected states, but also representations of desired or goal-consistent states (Pezzulo et al., 2015). With this insight, homeostasis and allostasis begin to map to PP. Basic homeostatic ranges or set points can be thought of as default, unconscious expectations—or, since moving outside those ranges motivates corrective activity (whether physiological or behavioral), as *goals*. For instance, if blood pressure drops, this is sensed and processed (unconsciously, interoceptively) in the brain stem, which orchestrates an appropriate response. This is an example of active inference: acting to maintain sensory states in accordance with priors. Further, if you touch a pan, not knowing that it was just on the burner, you will not likely keep your hand there while you update your expectation of the sensation of pain. You will very quickly remove your hand, via reflexes initiated at the level of the spinal cord, to bring sensations back in line with the instinctual goal of not being in pain: again, active inference.

Whether guided by subcortical patterns or conscious executive function, allostatic regulation changes or overrides homeostatic ranges (i.e., via top-down modulation of priors) to co-opt reflexes in service of goal-directed activity.[38] For example, with stress, the set point of blood pressure rises to accommodate physical exertion (for more complexity of this example, see Berntson et al., 2016a).

[38] Voluntary motor control is explained within PP in the same way as these visceral mechanisms: priors are modulated to co-opt spinal reflex arcs to produce movement (Adams et al., 2013).

Thus, a threat response stems from active inference based on a particular predictive model; safety learning updates that (implicit) model. What is relevant to perception, by these accounts, is not so much the perceived thing in itself, but its meaning in relation to us and our goals—and the response that should be mobilized. That is, an important part of what is modeled is the self and its efficacy (e.g., whether and how we might manage a threat). With this foundation of predictive processing in perception and regulation, we can now turn to interoception: the basis of the model of the self (Seth and Tsakiris, 2018).

### 3.2. Interoception

Interoception is "the process by which the nervous system senses, interprets, and integrates signals originating from within the body" (Paulus et al., 2019, p. 98). Interoceptive signals influence all manner of organismic processes (Azzalini et al., 2019). For example, when hungry, cues of food become more salient, motivation is rallied via reward networks, and smell and taste are heightened (Avery et al., 2017; Strigo and Craig, 2016). Indeed, interoception in service of adaptive regulation has recently been proposed as the core function of the brain (Kleckner et al., 2017). As Damasio reminds us, "The mind had to be first about the body, or it could not have been" (Damasio, 1994, p. xvi). At each level of its sensory hierarchy (addressed next), interoception affects self-regulatory dynamics.

#### 3.2.1. Interoceptive sensation: Bottom-up

The brain receives information about the state of the body through two primary pathways: humoral (i.e., endocrine/immune signals transmitted through the blood) and neural. We have already mentioned some impacts of the humoral component (section 2.2.4) and will here focus on the neural component—in particular, the vagus[39]. The vagus, discussed in section 2.3 as the primary component of the "rest and digest" parasympathetic nervous system, is also the main player in interoceptive sensation. Via its bottom-up pathways, the vagus signals to the brainstem; top-down, it initiates regulatory action. From the level of the brainstem, as interoceptive information propagates up the sensory/regulatory hierarchy, it becomes more integrative of other kinds of information, yet also less fine-grained.

A quick analogy with visual perception will help us understand interoception. Vision is presented to consciousness as a gestalt, but perception of details requires more volitional attention

[39] The glossopharyngeal nerve is the other cranial nerve associated with interoception, i.e., of the throat. Traditionally, interoception has been interpreted as specific to the viscera, but recent neuroanatomical investigations (Craig, 2002, 2013) now include certain kinds of sensory nerves from the skin (i.e., those that sense temperature, pain, and sensual touch), which have a pathway in the spinal cord distinct from other nerves from the skin, joining that of the vagus in a specific nucleus of the thalamus before proceeding to interoceptive cortex (see next subsection). This skin-sourced aspect of interoception will be addressed in the next chapter.

(see Fig. 5) (Campana and Tallon-Baudry, 2013; Tallon-Baudry et al., 2018). The shape of this gestalt, however, is highly dependent on past experience, in the same way that speech occurs as words rather than as meaningless noise. That is, it depends heavily on priors.

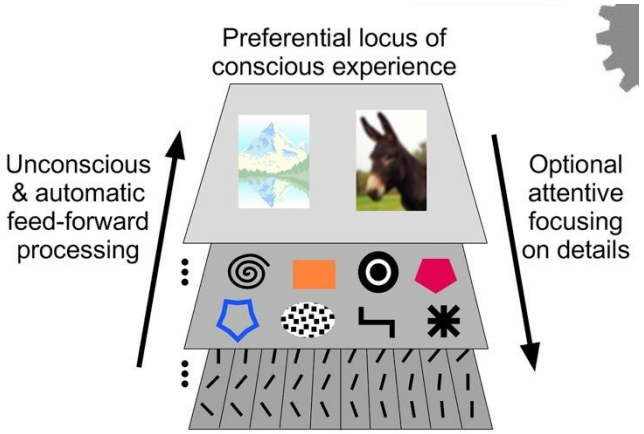


*Figure 5. Automatic versus detailed perception. Vision is processed and presented as a "coarse vivid" whole, "at a glance", whereas details are available for "vision with scrutiny" (Tallon-Baudry et al., 2018). Similarly, the anterior insula is associated with the gestalt interoceptive awareness, whereas the posterior insula is associated with volitional attention to interoceptive sensation (see section 5). Figure from Tallon-Baudry et al., 2018, Creative Commons.*

Patients with damage to their primary visual cortex become cortically blind and report no subjective experience of sight. However, though the cortex has no access to the information propagating from the retina, the "low road" is still carrying traffic. In these "sightblind" patients, subcortical structures like the amygdala still orchestrate the normal changes across brain and body in response to emotionally salient visual stimuli (Celeghin et al., 2015). Similarly, though interoception has many impacts through unconscious routes, it becomes conscious at the interoceptive cortex: the insula.

#### 3.2.2. Insula

The insula is a hidden lobe of the cortex, tucked under the temporal lobe, right next to the limbic system (see fig. 3). The anterior insula is implicated in the conscious, integrated sense of "how you feel" (Craig, 2014)[40], analogous to the "coarse vivid" gestalt of vision experience. It is a key node in multiple large-scale brain networks (Uddin, 2015), lights up in every brain scan related to emotion (Craig, 2014), and plays a key role in accounts of interoceptive predictive processing. But before interoceptive signals reach the anterior insula, they first come from the thalamus to the

[40] There's recently been a shift in the understanding of the neural correlates of mental processes, from the idea that a particular experiential phenomenon "happens" in a particular brain region, to the idea of brain regions as hubs in functional networks, the coordinated activity of which is responsible for mental processes (e.g., Pessoa, 2018). This is consistent with the understanding of the brain as a complex adaptive system, with the capacity for workarounds and redundancy, as well as natural inter-individual variation. Thus the rare cases in which a patient with bilateral insula or amygdala loss still has the capacity for feeling, or fear (Feinstein et al., 2016).

posterior insula, regarded as primary interoceptive cortex (Farb et al., 2013). The posterior insula is organized *somatotopically*, wherein its spatial organization corresponds to the spatial organization of the body, indicating that the representation is less abstracted. By the time the signal reaches the anterior insula, it no longer has that mode of organization. As we will see in section 5, conscious attention to bodily sensation preferentially activates the posterior insula and its connectivity with the thalamus (Farb et al., 2013).

#### 3.2.3. Interoceptive Predictive Processing: Top-down

As mentioned, PP applies not only to exteroception (vision, audition, etc.), but to interoception, as well, with some important differences (Barrett and Simmons, 2015; Seth, 2013). With exteroception of an object, the predictions alter the perception, but not the thing from which the signals are emanating. With vision, for example, the way to alter the signal is to get another angle on the thing in question through movement, or to act on it through explicit engagement or manipulation. Inside the body, however, the predictions are *already initiating changes* in physiology. This happens because the brain regions of prediction are tightly coordinated with the brain regions of activation: sensing is in service of regulation, and prediction is in service of allostasis (Kleckner et al., 2017). If the resulting active inference stemming from a perception doesn't resolve prediction error (PE), these "visceromotor" cortices, rather than updating via perceptual inference, can potentially push on to fulfill their own prophecies, ingraining a poorly attuned cycle of physiological activation, allostatic load, and dysfunction (Barrett and Simmons, 2015).[41]

In addition, the visceromotor/sensory interoceptive networks in the brain have considerable overlap with those of emotion and decision-making (Poppa and Bechara, 2018). In keeping with this overlap, addiction (Verdejo-Garcia et al., 2012), various mood disorders (Paulus and Stein, 2010), and poorer emotion regulation (Füstös et al., 2012) have been found to correlate with interoceptive dysfunction. The same correlation has been shown for *alexithymia* (Murphy et al., 2018), a continuum of emotional unawareness, the extreme expression of which is called *affective agnosia*: i.e., the inability to know emotion (Lane et al., 2020).

### 3.3. Dysfunctional interoception

[41] At the top of the visceromotor hierarchy (though not at the top of the regulatory hierarchy) are the anterior insula and vmPFC, as well the anterior cingulate cortex (ACC), a crucial part of the limbic-regulating mPFC. These regions set into motion autonomic and endocrine responses *via* the limbic system, with the ACC as prominent player. Anterior insula and ACC are understood to be closely linked in this regulatory function, with the former as gestalt awareness and the latter as response (Medford and Critchley, 2010). Underscoring their regulatory importance, low volume of these two regions has been associated with psychiatric conditions across diagnoses, and with worse executive functioning in non-psychiatric populations (Goodkind et al., 2015).

Before moving on to discuss the role of interoception in human emotion, we will conclude this section with some examples of clinical consequences of poor interoception. In previous sections, I have emphasized the importance of the prefrontal cortex (PFC) in updating the predictive model for healthy self-regulation (WB); in the coming pages I provide evidence that interoception plays a key role in that process.

#### 3.3.1. Poor Sensing: Depression

For example, according to prominent models (Barrett et al., 2016; Harshaw, 2015; Stephan et al., 2016), poor interoception is a key component of depression. Framed in terms of PP, it is posed that there is a tendency for interoceptive signals (and the prediction errors stemming from them) to fail to reach visceromotor cortices with enough confidence to update predictions (poor bottom-up integration). Due to low-precision sensory data, PE will fail to lead to the update of the predictive model (Barrett et al., 2016; Stephan et al., 2016). The resulting chronic interoceptive PE can lead to continued, poorly calibrated visceromotor activity (allostatic load), inflammation, fatigue, and depression. Particularly interesting with respect to these theories is the finding that better access to bodily sensation during sadness is *inversely* associated with depression (Farb et al., 2010). Further bolstering these models is the finding that a common class of orally administered antidepressants[42] has its effects *via* the vagus (McVey Neufeld et al., 2019). Resonant with this finding, vagal nerve stimulation is highly effective against otherwise treatment-resistant depression (Aaronson et al., 2017). We can thus conclude that dysfunctional interoception is implicated in depression.

#### 3.3.2. Poor Appraisal: Anxiety

Not all pathologies associated with interoception, however, are due to a failure of sensing[43]. A key aspect of dysfunctional interoception often occurs in the manner of *appraisal*: i.e., how the predictive model construes the signal's *meaning* (Farb and Logie, 2018; Mehling, 2016). As exteroceptive cues can signal threat and bodily reaction, interoceptive signals can also come to trigger defensive patterns. Panic and anxiety, for example, are characterized by above average performance on some interoceptive tests. The issue is rather of hyperreactivity to interoceptive sensation, due to over-precise priors about what those signals predict (threat), thus setting off allostatic regulation at the level of the amygdala. That is, the anxious are fear conditioned to their own sensation, and are hypervigilant to it.

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[42] selective serotonin reuptake inhibitors, SSRIs

[43] There are a variety of interoceptive dimensions and different ways of assessing them. For two excellent lists of interoception concepts, see (Farb et al., 2015) and (Harshaw, 2015). The most commonly used dimension is "interoceptive accuracy", generally assessed via a heartbeat counting task or a heartbeat detection task.

### 3.3.3. Overwhelm: PTSD

An extreme example of hypervigilant, overgeneralized fear-learning occurs in post-traumatic stress disorder (PTSD), such that context-specificity is slim to none (Wicking et al., 2016). For instance, in an fMRI study, playing a video simulating direct approach by a kind-looking man triggered defensive reactions in patients with PTSD (Steuwe et al., 2014).

Like the inverse of Elliot in the IGT, who knew which decks were bad, but chose from them anyway, those with trauma can "know" that a situation is safe, and yet their bodies still respond with the unresolved, unfelt arousal of the traumatic event. In order to update their implicit model, they must be supported to increase their capacity to feel the body without dissociating; i.e., keeping the PFC online. As trauma expert Bessel van der Kolk writes, "Trauma victims cannot recover until they become familiar with and befriend the sensations in their bodies" (2015, p. 102).

## 4. Emotion

Emotions are interwoven with every major aspect of human existence and experience. Thus, any attempt to understand human being and well-being must account for emotion. As discussed in Chapter 2, many ideas of what "well-being" means (the hedonic notions) focus exclusively on emotional experiences and assessments (e.g., Kahneman et al., 1999). In clinical accounts of wellness, emotional dysregulation is a core feature of psychopathology (Beauchaine and Cicchetti, 2019), and in the organismic-eudaimonic account being developed here, emotion is at the center of the self-regulatory hierarchy. Importantly, the examples in the previous section suggest that emotion is intimately related to interoception. After discussing this connection, this section briefly addresses emotion regulation.

As we will see here, the reason emotion and its regulation are so closely connected to interoception is that interoception is the foundation of emotion. Neurobiologically, emotion orients the organism (the brain-body system) through impacts on physiology, attention, perception, and cognition, readying it for goal-directed[44] action according to its predictive model (Damasio, 1994). The *experience* of emotion involves the contextualized assessment of the meaning of those bodily states, based on prior experience (Barrett, 2017). Thus, emotional awareness depends on the development of a predictive model. However, like interoception itself, emotions can be conscious or unconscious (Smith and Lane, 2016, 2015). Emotions that have enjoyed a healthy developmental trajectory are better integrated into and available to awareness, in more nuanced ways (Lane and Schwartz, 1987; Roth et al., 2019; Wallin, 2007). We turn next to the stages of

[44] As mentioned, these goals are not just personal, but also evolutionarily inherited, e.g., for homeostasis/survival.

this development and their connection with WB.

### 4.1. Levels of Emotional Awareness

To understand the relation of interoception to emotion, we turn to a developmental model, Levels of Emotional Awareness (Richard D. Lane, 2000; Lane and Schwartz, 1987). The levels are, briefly: sensation, action, single emotion, blends of emotion, and the more complex blends of blends of emotion. Higher scores on the Levels of Emotional Awareness Scale (LEAS; Lane et al. 1990) are associated with less repression of emotional experience (Richard D. Lane, 2000) and better self-reported impulse control (Bréjard et al., 2011). Further, essential hypertension, as compared to secondary hypertension caused by another medical condition, has also been connected to lower LEAS scores, indicating that low emotional awareness is likely causal of physiological dysregulation (Consoli et al., 2010). These findings are consistent with the understanding that better self-sensing is associated with better regulation, across domains. In this section, we will focus on the first two levels as being particularly strong deficits more clearly associated with pathology. (The next chapter will discuss the contexts that support emotional development.)

#### 4.1.1. Emotion as bodily sensation

At the first level, emotions set into motion involuntary bodily activation at low levels of the neural hierarchy (autonomic, endocrine) and also facial expressions and muscular tension (Lane and Schwartz, 1987). If conscious, they are experienced only as bodily sensations. This is the prototypical case of alexithymia[45] (the inability to recognize one's emotions), which has been strongly connected with poor interoceptive sensing (Murphy et al., 2018). Trauma expert Bessel van der Kolk tells of such a patient, with a history of childhood trauma, who whenever her husband made an insensitive remark, would have an asthma attack that sent her to the emergency room (Van der Kolk, 2015, p. 99). PTSD, also associated with low emotional awareness (Frewen et al., 2008), often presents chronic pain with no medical explanation (Levine, 2010). Regardless of trauma history, these "medically unexplained symptoms" are negatively correlated with both interoceptive function (Ricciardi et al., 2016) and LEAS score (Subic-Wrana et al., 2005).

#### 4.1.2. Emotion as action

The second level includes sensation and action tendencies, with overt action aimed at minimizing distress, but still without the conscious experience of emotion as such. This stage roughly corresponds to limbic-orchestrated behavior and the reliance on overt action to reactively,

[45] Also, for those who have generally normal emotional experience, in a particular context, an emotion may be unconsciously assessed as too threatening to acknowledge *as emotion*, leading to its being defensively excluded from awareness. However, subcortical regions continue to activate in response to the ongoing threat, leading to somatic symptoms (e.g., chronic pain) or other forms of dysregulation (Smith and Lane, 2016).

unreflectively, manage the sensation when it is aversive.[46] This "overt active inference" (Farb et al., 2015), distinct from the internal active inference of automatic physiological change, is the defining symptom of various pathologies, including disordered eating and addiction (see below). Key in continued development is the switch to perceptual inference, which permits a more nuanced appraisal of the sensations and a more adaptive way of responding.

For instance, in a clinical study with female addicts, interoceptive training supported the women to identify their sensations as signals of emotion, cuing the need for self-care. This shift to perceptual inference allowed them to relate to themselves in a new way, rather than to continue in the habitual compulsion to change the sensation with drugs (Price et al., 2012a, 2012b).

Disordered eating is another example of a maladaptive mode of self-regulation: i.e., active inference based on an underdeveloped interoceptive predictive model. It correlates with both poor interoception (Martin et al., 2019) and low LEAS scores (Bydlowski et al., 2005). Clinicians have long noted a lack of emotional and body awareness in those with eating disorders (e.g., Bruch, 1982). If there is awareness of the emotions that precipitate the behavior, it is often superficial and disconnected from a deeper understanding of its source (e.g., Krueger, 1989, pp. 80–82). Instead, the sensation associated with it is aversive, and it is compulsively managed through action.

### 4.2. Developing awareness beyond reaction

The above examples suggest that feeling the body, instead of reacting to it, can allow *insight* to arise (Farb et al., 2015): i.e., a deeper recognition of the source or meaning of the sensation as emotion, thus updating the causal model and providing the possibility of other coping/regulatory strategies (more adaptive active inference; e.g., taking a walk, journaling, talking to a friend, doing yoga). Further, these data points suggest that interoceptive maturity and emotional maturity are results of the same process of developing a well-calibrated interoceptive predictive model, yielding more integrated modes of self-regulation.

Active inference, though clearly important for achieving desired states, if overly relied upon, can serve to keep a predictive model (its categories, meanings, and response patterns) underdeveloped and crude, with relatively narrow (and potentially increasingly unattainable) bands of desired sensation ranges; overprecise, inaccurate priors generating a constant prediction error (PE) signal (Farb et al., 2015). With only active inference, we may flounder in a perennial

[46] As told by Kosten et al. (1992, p. 563):

> Patients with alexithymia substitute action and descriptive words for affective language (Taylor, 1984). When these patients are asked "How would you feel if you saw a truck coming at you at 90 mph?" instead of responding "I would feel scared," they might reply "I don't know. No feeling; I'd get out of the way." (This was a response by a Vietnam veteran with post-traumatic stress disorder—PTSD.)

active search for the thing that will make us feel the way we think we are supposed to. The capacity to stop and feel allows a widening and diversifying (and thus a lowering of the precision) of interoceptive predictions (Farb et al., 2015). This supports a more nuanced, context-specific interoceptive appraisal, such that insight can occur, the model can be updated, and more effective action can be initiated if necessary. The next subsection discusses these processes as control versus integration.

### 4.3. Emotion regulation

Emotion regulation has often been defined in terms of strategies for changing one's emotional state or its expression (e.g., Gross, 2015). Such strategies include reappraisal, suppression, and distraction. Reappraisal is a cognitive strategy of reframing the situation, generally to down-regulate undesired emotional experience (e.g., by considering that someone who has just been rude to you is likely having a bad day). Suppression attempts simply to inhibit the experience and expression of emotion, and distraction is a means of attentional avoidance to preempt further processing of the emotion (Bonanno and Burton, 2013). Reappraisal has generally been considered the more adaptive strategy, but more recent research poses that rather than relying on a single strategy, context-specific (and feedback-responsive) regulatory flexibility is associated with the best outcomes (Aldao, 2013; Bonanno and Burton, 2013). This, in turn, is served by *integrated emotion regulation*, addressed next.

Notably, the above strategies (as generally conceived) are forms of emotional control. As opposed to self-organization as an integrative process, self-control is internally antagonistic, i.e., less coherent and integrated, showing concomitant decrements in WB (Ryan and Deci, 2017). In contrast, integrated emotion regulation involves non-defensively engaging with emotional experience as providing valuable information about one's values and motives, "thereby yielding the potential to enhance individuals' capacities for choice and authenticity" (Roth et al., 2019, p. 946).[47] That is, integrated emotional regulation supports greater organismic coherence, leading to more effective and flexible deployment of appropriate regulatory strategies.[48] Along these same lines, better interoception is associated with more flexible and effective emotion regulation (Kever et al., 2015).

### 4.4. Emotion Summary

[47] Emotions can be appreciated as informing the conscious "experiencer-agent" self associated with the PFC (Smith, 2017) about the deeper organismic self, allowing for a more integrated psyche. In keeping with this idea, LEAS correlates with a higher degree of integration in the brain (Smith et al., 2018).

[48] This is the basic principle of the martial art, Aikido, which translates to "the way of harmonizing energy" (Ueshiba, 2002). Rather than countering the force of an assailant head-on, by aligning with their momentum, it can be harnessed and directed. See also the Taoist principle of nonresistance (Hoff, 1982).

The basic thesis of this chapter is that self-sensing is required for self-regulation, and further, that well-developed self-sensing is required for the integrated regulation that underlies high WB. The research discussed in this section emphasizes that this includes emotion regulation, with interoception as the foundation of emotional life. We've seen here that healthy emotional development (i.e., building a well-calibrated interoceptive predictive model) is supported by the ability to observe internal states non-defensively, without trying to change them. Such non-reactive awareness is a key component of mindful attention. The next section discusses the role of attention in regulation, highlighting processes involved with mindful attention in particular.

## 5. Attention and Regulation

Recall that in predictive processing, the response to prediction error (PE) depends on adjusting the confidence in priors vs. sensory data (Fig. 4). An important determinant of this process is attention (Ainley et al., 2016). For instance, a marker of the cortical processing of the heartbeat called the "heartbeat-evoked potential" (HEP) increases in amplitude with attention to the heart (Petzschner et al., 2019). Higher HEP amplitude in turn predicts better cardiac interoceptive accuracy (Mai et al., 2018; Pollatos and Schandry, 2004).

One experiment used fMRI to investigate the contrasting brain activity of exteroceptive attention versus interoceptive (respiratory) attention (Farb et al., 2013). The study found interoceptive attention to increase activity in the posterior insula, as well as connectivity in the bottom-up pathway between the thalamus and the posterior insula—but no difference in anterior insula activity.[49] Further, in an unusual experiment utilizing fMRI not of the brain, but of the spinal cord (i.e., further down the sensory hierarchy), attention to specific body parts increased activity in the corresponding part of the spinal cord (Nejad et al., 2014). This effect was particularly strong in experienced meditation practitioners, i.e., those who have developed their capacity to direct interoceptive attention intentionally. Another experiment looked at the effects on interoception of a simple attentional "body scan" practice performed 20 minutes a day for 8 weeks, finding significant improvements in interoceptive function (Fischer et al., 2017). These findings strongly suggest that present-moment attention to bodily sensation weights bottom-up processing over predictions.

### 5.1. Mindfulness as interoceptive practice

The practice of mindfulness develops a non-judgmental, non-reactive, present-moment style of

[49] Recall that the posterior insula has a finer grain of detail than the anterior insula's gestalt-type, overall, top-down representation.

awareness, often tuned to bodily sensation (Kabat-Zinn, 2009).[50] This is precisely the kind of awareness needed to increase sensory precision and update priors; i.e., for perceptual inference. There is, in general, a strong interoceptive element to mindfulness practices, but there are cognitive elements as well. Interesting for our exploration is an experiment on mindfulness interventions for chronic worry (Delgado-Pastor et al., 2015). In order to test the differential effects of the cognitive versus interoceptive elements of mindfulness, separate interventions were administered to two groups. While both cognitive and interoceptive mindfulness yielded improvements in self-report and clinical symptoms, the interoception group also showed improved autonomic regulation (i.e., decreased sympathetic activation as shown by lower heart rate and skin conductance, combined with increased vagal tone as shown by higher heart rate variability).

We might expect this kind of improved autonomic regulation to have corresponding changes higher in the "neuroaxis" of the central autonomic network (CAN). Indeed, investigating changes in limbic function due to attentional practice, brain imaging studies have found that participants in an 8-week mindfulness training showed significant reductions in amygdala volume (Hölzel et al., 2010) and stronger prefrontal-amygdala connectivity (Hölzel et al., 2013) by the end of the program. Importantly, in that connectivity, Holzel et al. (2013) found a pattern of activation counter to the normally-considered ideas of simple down-regulation or mutual inhibition. Suggesting a process like that described by integrated emotion regulation, mindful attention was associated with coactivation: that is, the PFC stayed online, matching amygdala activation. Rather than an antagonistic inverse relationship, it seems mindfulness supports integrated regulation, which in this study was associated with decreased anxiety.

Thus, we can conclude that the PFC's regulatory capacity—not only to inhibit the reactivity of the amygdala (and its associated maladaptive stress patterns), but to stay online in the face of arousal—is strengthened through practices of *attending to the body*. As the interoceptive activity of the vagus supports the PFC, so the PFC supports the parasympathetic activity of the vagus.

## 6. What is healthy interoception?

From the above exploration, we can assess that healthy interoceptive awareness is neither hyper- nor hypo-reactive. It entails the capacity to attend without habitual reactivity, but neither is it impervious to new data. Rather, a healthy interoceptive awareness remains open to *perceptual inference*, i.e., updating the predictive models that serve as perceptual "priors" and their associated

[50] For instance, in meditation, one might watch the breath, repeatedly returning to the sensations of breathing whenever one's attention gets lost in thought.

regulatory/response patterns. This means that behavioral responses will tend to be more adaptive and attuned to the particular circumstance and context. That is, perceptual inference in the interoceptive realm contributes to more accurate understandings of world, body, emotion, and self—leading to adaptive regulation and physiological, emotional, and mental health.

Healthy interoceptive development involves learning to appreciate bodily signals (i.e., including emotions) as providing valuable information about oneself (e.g., that self-care is needed), rather than as troublesome experiences to be defensively managed, controlled, or avoided. Engaging this development remedially, as it were, to resolve disconnections from bodily experience, is part of effective treatment for a variety of diagnoses, as well as the psychotherapeutic process in general (e.g., Grabbe and Miller-Karas, 2018; Fogel, 2013; Lane et al., 2015; Wallin, 2007). That is, mindful attention to the body provides an excellent avenue for self-awareness, integration, and better self-regulation and WB (Fogel, 2013). For clinical populations, it is important that this be skillfully facilitated, since engaging what has been too overwhelming (and thus defended against) can reinforce aversive learning, exacerbating instead of relieving the issue (Treleaven, 2018).

In general, though, developing the capacity to stay present to the sensations of the body increases resilience to potentially traumatic experiences, allowing the PFC's flexible response to be robust and able to stay online in the face of greater intensity and arousal (Haase et al., 2016; Koenig, 2020). Well-developed interoception supports well-attuned self-regulation in the face of a wide range of inner and outer circumstances.

## 7. Conclusion

Adaptive self-regulation requires self-sensing. Specifically, it requires *non-defensive* self-sensing, from which appropriately nuanced sense-making arises naturally via the generation of a predictive model of self and world. This all rests on an attuned relationship with the body.[51]

On the way to this conclusion, this chapter laid the foundation for the organismic-eudaimonic perspective, showing how the functioning of neurobiological systems impacts our experience, as well as how our experience impacts our neurobiology, with pervasive consequences for physiological and psychological health and WB. Defensive modes of regulation are associated with lower WB. In particular, we've seen that a non-defensive relationship to bodily experience enhances regulatory capacity and WB. Attending to the body in this way allows the weighting of

[51] This chapter has focused on interoception, but it should be noted that a more complete account of embodiment would include proprioception: the sense of the body in space, of the musculo-skeletal system (sensing movement and muscle tension), etc. See (Fogel, 2013) for such an inclusive treatment.

bottom-up signals, cortical processing, and the updating of predictive models, such that more effective regulatory action (both internal and external) becomes available. Habitual patterns are no longer maladaptively triggered, because the category of meaning that provokes the reactivity is appropriately contextualized. To the degree that the model remains unattuned or underdeveloped, dysregulation throughout the homeostatic-allostatic regulatory hierarchy will result.

For flexible, adaptive regulation, we need the central autonomic network (CAN) to be integrated, from the PFC to the interoceptive/parasympathetic vagus[52], so that the bottom-up can reach consciousness and update the model, rather than set into motion limbic reactivity. A crucial mediator of that process is attention. Because the experience of emotion is rooted in interoception, mindful attention to the body also supports the consciousness, understanding, acceptance, and integrated regulation of emotions, such that lower-level (i.e., physiological) dysregulation is reduced, and higher-level regulation is more available.

Self-sensing and self-regulation are deeply intertwined, throughout the neuroaxis. The physiological activity of the body has widespread impacts on "mind"; i.e., experience, attention, etc. But the way we pay attention, too—i.e., the way we relate to bodily experience—plays a crucial role in bodily processes. This chapter has provided a wealth of evidence that the quality of the relationship to our own internal bodily experience is a core determinant of health and well-being.

Crucially, as we turn to in the next chapter, this relationship is developed in the context of relationships to other humans, which are a strong determinant of interoceptive and regulatory function.

[52] Because heart rate variability (HRV) is also a strongly supported measure of such regulatory function, an interesting question is whether HRV correlates with measures of interoceptive function—i.e., between the motor and sensory aspects of the vagus. Though it seems an obvious question to me, I have not been able to find any studies investigating this relationship. If I have not simply missed this in the literature, I suggest this as a fruitful direction for future research.

# Chapter 5 – Sociality

## 1. Introduction

This chapter explores some of the implications of our social nature as human beings, showcasing some powerful impacts on well-being. As discussed in Chapter 2, the organismic-eudaimonic approach to well-being focuses on regulatory dynamics as the underlying basis of well-being (WB). The last chapter investigated processes within the individual. However, since the human is an open system, in dynamic relationship with its contexts, an adequate understanding of those processes as they develop over time is not possible unless we look beyond the individual. The interpersonal level of analysis is not captured in, but has powerful impacts on, the intrapersonal level. Therefore, this chapter explores sociality as an integral aspect of human being and WB.

The basic thesis of this chapter is that self-regulation is developed and maintained through co-regulation, a dynamic process of attunement between self and other, and that therefore social disconnection is associated with dysfunction. Where the last chapter discussed how self-sensing is crucial for self-regulation, impacting physiology, emotions, agency, and coherence of self, this chapter notes that these dynamics happen in, and are profoundly shaped by, social contexts (Fotopoulou and Tsakiris, 2017; Gross and Medina-DeVilliers, 2020; Hari et al., 2015). Given that we are "obligatorily gregarious" (Cacioppo and Patrick, 2008), being integrated in our social contexts is a homeostatic expectation of the human organism (Coan, 2016). This chapter discusses the detrimental impacts of sub-optimal social connectivity in development and throughout the lifespan. In doing so, it emphasizes that an adequate understanding of the human and its WB must account for the quality of its past and present relational contexts.

We start with some classic studies of maternal impacts on development in non-humans, before moving to human psychological development in sections 2 and 3, and connecting to neurobiology in section 4. Section 5 examines some key aspects and outcomes of the relational modality of touch, and section 6 connects relational processes to interoception. Section 7 builds on this linkage, noting the role of the vagus[53] in organizing social engagement. Moving on from a predominantly developmental focus, section 8 gives an overview of the impacts of social (dis)connection throughout life. Given the importance of connection versus disconnection, section 9 aims to articulate their key characteristics, i.e., what kinds of relationality are most optimal for development and WB.

The section 10 brings the chapter more explicitly into the frame of the previous chapter,

[53] As discussed in the previous chapter, the vagus is the main channel of both the "rest and digest" parasympathetic nervous system, and visceral interoception.

and into conversation with its themes of predictive processing (PP), interoception, and mindfulness, exploring the means of prediction-error minimization in "relational predictive processing" (RPP). The final section, before concluding, briefly points to the importance of wider social contexts by noting a few examples of their impacts on relational and well-being dynamics.

A classic experiment offers an excellent entry point for our exploration. The intellectual context for this experiment, however, should be briefly mentioned first. Thus, we begin with the behaviorist notion of child development.

### 1.1. Behaviorist backdrop

Behaviorism was the reigning school of thought in American psychology in the 1950's. Behaviorism assumed (similar to neoclassical economics) that behavior can be controlled through external means, i.e., punishment and reward (Watson, 1913). As led by John Broadus Watson, behaviorism taught that love and affection were rewards that should be withheld and applied dependent on a child's conforming to the desired behavior. He advised parents, "Never hug and kiss them, never let them sit in your lap. If you must, kiss them once on the forehead when they say good night" (Watson, 1928).[54]

Behaviorists assumed that the infant's bond to its mother was based on reinforcement due to the provision of milk, i.e., the satisfaction of a material need. One of the most well-known "animal experiments" in psychology was in response to this ideology, as we turn to next.

### 1.2. Harlow's monkeys

In an experiment with monkeys raised by two "surrogate mothers", one of wire and one of soft cloth, the infant would be expected (according to behaviorism) to bond, or "attach", to whichever one had the bottle of milk affixed to it. This was not at all what happened. The infants clung to the cloth mother, keeping as much contact with it as possible while stretching to the bottle on the wire mother (Harlow and Zimmerman, 1959). As important a finding as that was (as evidence against behaviorism), a more important finding was that the infants raised in such a manner, i.e., without a relational context, were later entirely socially inept. Though supplied with sufficient nutritional inputs, they were deprived of the experiential inputs crucial to development, and so did not achieve the regulatory capacity required for social life.

### 1.3. Development as an evolved, dynamic process

As recognized by the field of evolutionary developmental biology, or "evo-devo", evolution does not just select for adult traits; rather, organisms must be viable at every stage of their life history

[54] That is, in the nature-nurture debate, Watson came down on the side of nurture, but recommended against it.

(Tomasello, 2019). Therefore, the species-specific timing of maturation (when various capacities become available for development) is no trivial matter. Crucially, these capacities require specific kinds of experience or contexts in order to come to fruition. Like the physiological parameters of homeostasis function as the expected (or goal) states of the organism, such environmental parameters can also be understood as innate *priors* (Friston, 2012). For social animals like birds and mammals, conspecific others (particularly the mother) form a crucial part of that experience necessary for development.

### 1.4. Quality of care organizes development

The role of those others' influence is not determined simply by whether they are present or absent, but the mode of presence, engagement, and interaction. Early experiences form the basis of the "predictive model" (see previous chapter) according to which regulatory systems operate, orienting its development in preparation for (i.e., adaptation to) a particular kind of world. For instance, in rodents, the amount of maternal care given (grooming and licking) configures the "settings" for core physiological systems (e.g., HPA, amygdala function) and alters the regulation of gene expression, through "epigenetic" mechanisms (Meaney, 2001). This foundation impacts regulatory function throughout the pups' lives, including reactivity to novelty and stress, social behavior, and (for females) future parenting style (Champagne, 2008). In order to investigate the balance of genes vs. environment in this heritability[55], the litters of mothers with high- and low-care styles were switched. The pups developed the neurobiology and behavior consistent with the kind of care received, demonstrating the determining role of early experience in biobehavioral development (Francis et al., 1999; Weaver et al., 2004), as well as a cycle of intergenerational transmission of regulatory and co-regulatory modes (Champagne, 2008). As shown in the coming sections, these findings translate to the human situation, as well.

## 2. Human Psychological Development

After a brief consideration of humans' particular evolutionary lineage, the next sections explore various aspects of these dynamics as they play out in human development.

### 2.1. Evolutionary inheritance

Humans diverged from our closest great ape relatives (chimpanzees and bonobos) about 6 million years ago; since then, building on the capacities shared by the last common ancestor, some key relational abilities evolved in the human line, alongside cooperative foraging, and later, tribal life

[55] See Laland et al. (2015) for a discussion of the extended evolutionary synthesis, which recognizes non-genetic (and epigenetic) kinds of inheritance.

(Tomasello, 2019). According to evo-devo researcher Michael Tomasello (who has spent his career studying the common and differing capacities of great apes and humans and when in the course of development those capacities come online), the two critical components are joint attention and joint intention. Not only are we *able* to align attention and share goals; we are innately and intrinsically motivated to do so. Infants align affect and attention with adults, and with repeated joint attention, a library of shared experiences is built, enhancing communicative ability and forming fertile ground upon which the human capacity for joint intentionality can take root (Tomasello, 2019). We here focus on the first element, the infant's orientation toward affect- and attention-alignment (or, synchronization) in dyadic interactions with caregivers.

### 2.2. Primary intersubjectivity and protoconversations

We are evolved for the coordination and interrelation of subjectivities; i.e., for intersubjectivity. Immediately after birth, an infant will make eye contact, mimic another person's facial expression, and even reproduce it the next day upon seeing the same person's neutral face (Meltzoff and Moore, 1998). In addition, infants detect, prefer, and respond more positively to adult behavior that is responsive (i.e., "contingent") to the infants' expressions (Tarabulsy et al., 1996). Over time, these invitations to relationship develop into a mutually regulated interaction, in which each partner is responsive to the other, adapting to and prompting changes in affect, arousal, rhythm, and attention. Such parent-infant interactions, occurring before the infant has acquired any linguistic capacity, have been termed "protoconversations" (e.g., Trevarthen, 1979). As will be discussed in more detail, synchrony/attuned responsiveness of the parent is a key part of a healthy developmental context, but its quality and consistency are highly variable from parent to parent, with characteristic influence on developmental outcomes.

### 2.3. Disruption and the still face

One demonstration of disruption to the synchrony of protoconversation is found in the "still-face paradigm" (Tronick et al., 1978). In this experimental set-up, after a session of normal face-to-face interaction, the mother adopts a neutral expression for three minutes. In this situation, babies generally begin by cooing and smiling, but when the mother remains unresponsive and apparently indifferent, the babies progress from uncertainty to distress and dysregulation, often reaching a state of hypoarousal and loss of postural tone (Ham and Tronick, 2009). As an infant in such an interaction is "constantly modifying his own communicative displays in response to the feedback provided by his partner" (Tronick et al., 1978, p. 10), so too does the infant adapt to the parent in normal, ongoing interactions. Over time, these adaptations of infant to parent tend to become relatively stable patterns, leading to biases of awareness, perception, and interpretation, with

behavioral strategies following from these (Ainsworth et al., 1978). That is, in the terms of predictive processing (PP) (discussed in the previous chapter), early relational experiences form the basis of the developing *predictive model* of self, world, and the dynamics between them. In the next sections, we look at the nature and outcomes of different patterns of parent-infant interaction.

## 3. Attachment Theory

In this section, attachment theory is highlighted because it is among the most prominent fields to study the impact of early experience on psychological development. After this overview, we connect to recent neurobiological research on biobehavioral synchrony and resultant self-regulatory dynamics and social behavior.

### 3.1. Infants and the strange situation: classifying attachment styles

Attachment theory began from studies of toddlers' long-term separation from their parents, e.g., through death or hospitalization (Bowlby, 1969). John Bowlby found a patterned progression of protest to detachment/numbing (similar to that found later in miniature form in the still-face paradigm). Bowlby hypothesized that human infants have an innate evolutionary need to maintain relationship with their caregivers, particularly the mother, and that these bonds of "attachment" are a crucial foundation for development, serving as a "safe haven" from which to derive comfort and safety in moments of stress and a "secure base" from which to venture out into the world. Observation of mother-infant interaction patterns in Uganda and Baltimore by Bowlby's collaborator, Mary Ainsworth, found correlation between maternal relational style and infant outcomes in terms of the balance between proximity-seeking and exploration. To further clarify these dynamics, she devised a "strange situation" experiment (Ainsworth et al., 1978). In the first phase, a mother and her 12-month-old are in a room with toys and a trained babysitter. In the second phase, the mother leaves, and in phase three, the mother returns.

#### 3.1.1. Secure

Many of the infants played in the presence of their mothers, cried upon her departure, and when she returned, reunited, were quickly soothed, and resumed play. These infants, classified as *secure*, had mothers who were observed in their homes to be generally well-attuned and responsive to the infants' needs, states, and signals, either for a particular kind of care/comfort, or for when, e.g., they no longer wanted to be held (Ainsworth et al., 1978).

#### 3.1.2. Avoidant

Another class followed a pattern of play during phase 1, but seemingly ignored the mother, showing no outward signs of distress when she left. Internally, however, such infants have been

found to show even greater physiological arousal than the securely attached infants (Hill-Soderlund et al., 2008). These infants continued to play when mother returned. Having apparently sacrificed attachment for exploration, these insecurely attached infants were classified as *avoidant*. In-home observation found that mothers of these infants were generally non-responsive or punishing of their children's bids for connection (e.g., rebuffing or withdrawing in response to crying), and the infants had apparently adapted by inhibiting their "attachment system" (Ainsworth et al., 1978).[56]

#### 3.1.3. Anxious

In the third pattern Ainsworth described, infants never left the mother to play with the toys, were overwhelmingly distressed upon separation (so much so that phase 2 often had to be cut short), and failed to be soothed upon reunion. These insecurely attached infants seemed to have sacrificed exploration for connection, and because they would frequently either resist/pull away from the mother, they were called resistant or ambivalent. Because they were anxiously preoccupied with the location of the mother throughout, this attachment style is most often referred to as *anxious*. Mothers of these infants had been observed to be only inconsistently responsive, and the infants had adopted a strategy of amplifying their attachment signals (as opposed to the avoidant strategy of inhibition). In addition, these mothers were frequently observed to discourage infants' autonomy (Ainsworth et al., 1978).

#### 3.1.4. Disorganized

A final attachment category that eluded classification for many years is characterized by bizarre or contradictory infant behavior, as if of terror, confusion, or collapse. Such displays were generally brief (less than a minute). These infants had parents who were, with some frequency or intensity, either frightening, frightened, or dissociated, often due to their own unresolved trauma or loss (Main and Hesse, 1990; Sun et al., 2017). Where secure, avoidant, and anxious styles are organized, adaptive strategies, there is no adaptive option available for these infants; their "disorganized" attachment style represents the collapse of strategy.

#### 3.1.5. Takeaways

Infants show patterned responses to different kinds of parenting. If the parent does not sufficiently adapt to the infant, the infant must adapt to the parent. Toward this end, the human seems to be

[56] Watson's description of the "happy child" as one "who *never cries* unless actually stuck by a pin […], *who loses himself in work and play*; who quickly learns to overcome the small difficulties in his environment *without running to mother*, father, nurse or other adult; […] who puts on such habits of politeness and neatness and cleanliness that adults are willing to be around him at least part of the day: a child who is willing to be around adults *without fighting incessantly for notice*" (Watson, 1928; p. 9, emphases mine) appears to describe the avoidantly adapted child.

endowed with basic strategies of adapting to the parent, corresponding to inhibition or amplification of expressions signaling need or desire for connection, with implications for the balance between exploration and attachment. The avoidant child exaggerates self-reliance, whereas the anxiously-attached child exaggerates dependence. As we will see next, these adaptations are not limited to expressed behavior; rather, they are pervasive regulatory biases.[57]

### 3.2. Attachment and the internal working model throughout the lifespan

Bowlby postulated that the infant's early experience with caregivers formed the basis for the development of an "internal working model" (IWM) of relationships, particularly those of attachment.[58] Such an IWM would influence later romantic bonds, as well as relationships with one's own child. As we next review, empirical work by Ainsworth's student Mary Main demonstrated these effects: early experience patterns not only behavior, but modes of prediction and expectation about relationships, facilitated by biases in attention and memory (Main et al., 1985).[59]

#### 3.2.1. From infancy to childhood

Five years after their participation in the "strange situation" experiment, 6-year-olds and their parents' attachment systems were primed by taking a family photo and watching a short film dramatically depicting parent-child separation, before being actually separated for the next phase of the experiment. The children were shown pictures of children about to be separated from their parents and were asked what the child would feel and do when their parents left. Their narrative responses (i.e., relational predictions) corresponded to their behavior in the strange situation 5 years earlier (Main et al., 1985).

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[57] Further findings strengthen this idea of amplification and inhibition as basic adaptive strategies for organizing attachment behavior in response to caregivers. For example, though the classic example yielding avoidance is the "predictably non-responsive" parent, an overly intrusive mode of insensitivity to the infant may similarly lead to avoidance (e.g., Crittenden and Landini, 2015), as in the "chase and dodge" pattern, potentially leading to the passive defensive strategy of collapse (Beebe and Lachmann, 1988). In addition, behavior leading to anxious attachment was originally characterized as "unpredictably responsive". However, mothers may have a pattern of only successfully reading infants' signals when those signals are loud and distressed, thereby reinforcing a pattern of amplification by being predictably non-responsive, albeit to the opposite end of the behavioral spectrum than is the case with the avoidant (see examples in Crittenden and Landini, 2015).

[58] i.e., a predictive model of relationship. Bowlby's understanding of predictive models was surprisingly nuanced and resonant with predictive processing accounts (see Bretherton and Munholland, 2016).

[59] Particularly under another of Ainsworth's prominent students, Patricia Crittenden, the early classifications have undergone further differentiation into more than 20 different types, incorporating as well the increased range or expression of strategies as the infant moves toward maturity. This organizational scheme, called the dynamic maturational model, keeps the basic categories (albeit with differently nuanced interpretations), and puts the subcategories on a continuum of how distortive the information processing involved is (Crittenden, 2006; Farnfield and Stokowy, 2014). The basic telling, however, is sufficient for our purposes.

### 3.2.2. From parent to child

The parents, meanwhile, were asked about their own parents and childhoods in the "adult attachment interview", designed to activate the attachment system. The structure of their responses, rather than the content itself, yielded adult attachment classifications, and corresponded to their child's classification. Parents of secure children tended to be objective, coherent, and reflective, and were termed secure/autonomous. Parents of avoidant children tended to be incoherent, denying both the importance and memory of attachment-related experiences, and were thus termed dismissive. These parents' strategy of internally rejecting awareness and memory of attachment was also applied outwardly in rejecting their child's bids for connection. In contrast, parents of anxious children tended to be overwhelmed and preoccupied by attachment-related memories (Main et al., 1985). These kinds of biases in processes of attention and memory (the avoidance and preoccupation characteristic of insecure IWMs) obstruct parents' ability to correctly perceive and adapt to their children's states/needs, thus prompting the child's distortive adaptation to the parent (e.g., Crittenden and Landini, 2015).

### 3.2.3. Adult attachment

Importantly, beyond their role in the intergenerational transmission of insecure attachment, these inhibitory/amplifying biases in relationship-related processing and behavior are, fundamentally, regulatory strategies. Ratings of attachment insecurity[60] correlate with a variety of difficulties: in emotion regulation, in relational quality, and as a predisposing factor toward psychiatric diagnoses (Mikulincer and Shaver, 2019, 2012, 2007). For example, in an fMRI study (Vrtička et al., 2012), avoidant attachment was found to correspond to less efficient emotion regulation (i.e., reappraisal), a pattern that may contribute to cardiovascular disease (Gianaros et al., 2014). Anxious attachment, consistent with its strategy of hyperactivation, corresponded to increased amygdala activation (Vrtička et al., 2012). Relatedly, attachment insecurity has also been associated with HPA dysregulation (e.g., T. Kidd et al., 2013). Further, in one study (Ein-Dor et al., 2018), high avoidance paired with low anxiety was found to correlate with epigenetic changes in the expression of receptors for both the glucocorticoid cortisol and the neurohormone oxytocin (OT, involved with bonding, stress regulation, and affiliative behavior; discussed further in section 4).

Thus, the early strategies revealed in the "strange situation" become (to varying degree) ingrained in attentional, cognitive, behavioral, physiological, and even epigenetic patterns: the

[60] In adults, attachment strategies are often plotted in two dimensions, with individual scores for avoidant and anxious tendencies. High score on both measures corresponds to the strong conflicting impulses of "disorganized" attachment.

IWM has lasting and pervasive impacts, throughout the regulatory hierarchy. [61]

### 3.3. Integration as fundamental drive

In complex systems, the adaptive balance of stability and flexibility is found when a system is well *integrated*. In broad terms, integration means that system components are differentiated (i.e., they have distinct identities and autonomy of purpose and behavior) but also linked (i.e., they coordinate with each other through mutual responsiveness). According to organismic accounts (see Chapter 2), organisms have an innate drive toward integration. This drive has also been widely recognized in the domain of human psychology. Many streams of thought and research—within attachment and intersubjectivity theories (Wallin, 2007), self-determination theory (SDT, Ryan and Deci, 2017), interpersonal neurobiology (IPNB, Siegel, 2020), and prominent psychoanalytic and developmental theories (Fromm, 1947; Rogers, 1951; Winnicott, 1965)—converge in identifying an *innate developmental drive* to wholeness, integration, and authenticity. In Winnicott's words, "The characteristic of the developmental process is the drive towards integration" (1965, p.239; quoted in Wallin, 2007, p. 58). This section explores some expressions of the principle of integration in the realms of human development, psychology, and relationship.

#### 3.3.1. Relational integration is the context for psychological integration

As discussed in the literature review, a central finding of interpersonal neurobiology (IPNB) is that integration is the basis for healthy regulation, which is the *sin qua non* of well-being (Siegel, 2012). As discussed in the previous chapter, an attuned and receptive relationship to bodily experience supports the integration of subjective aspects of the self (e.g., emotion) and (relatedly) the integration of the brain (e.g., prefrontal-limbic connections). IPNB emphasizes that such inner integration is best nurtured in integrated relationships—i.e., those in which we are distinct but linked, in which there is room for our full, integrated selves while still being in connection.

Similarly, in self-determination theory, (SDT, Ryan and Deci, 2017), the drive to integration is understood as both inner (toward psychological integration) and outer (toward integration within one's social context). As we shall see, impairments in one result in concomitant

[61] As with the rodent, whose early experience communicates what kind of world to which to orient its neurophysiology, so with humans are there kinds of worlds for which insecure strategies are (at least reproductively) adaptive (Szepsenwol and Simpson, 2019). That is, it adapts to a particular context, but is not *flexibly* adaptive: when the context changes, the previous adaption is maladaptive. Insecurity corresponds to a faster "life history strategy", the evolutionary logic being to go ahead and reproduce quickly because you might not survive long enough to do so later (like a plant that "bolts" to reproduction when conditions are poor). The problem, however, is that the faster the life history strategy, the greater the likelihood of pathology (Hurst and Kavanagh, 2017). Secure attachment forms the basis of a slower life history strategy that invests time and resources in the long-term, according to a predictive model of the world as sufficiently reliable—such that, in economic terms, the future is less "discounted" (e.g., C. Kidd et al., 2013).

impairments in the other: insecure attachment leads to defensive exclusion of parts of the self *and* to more relational difficulty—i.e., to issues with both inner and outer integration.

### 3.3.2. Integration via attuned responsiveness: Being joined facilitates development

A crucial question in parent-child dynamics is what experiences can and cannot be shared (Stern, 1985, p. 208). "An intention, feeling, or attentional focus that evokes an attuned response is one that is sharable and thus can be integrated into the child's sense of self, whereas one that fails to evoke such a response can neither be shared nor integrated" (Wallin, 2007, p. 54). That is, joint attention is a key developmental resource. Much of what follows in this chapter reiterates this point.

Two key features of the attuned responsiveness characteristic of integration are that it is *contingent* and *marked*. Contingent responses accurately resonate with and reflect back to the child her state, communicating understanding. When *marked*, expressions are not identical, but somewhat processed or modulated, so as to communicate that a) this is your emotion, not mine, and b) I can handle it; it is shareable, not simply contagious (Wallin, 2007, pp. 48–51). Failure to mark conveys linkage without differentiation (typical of anxious attachment); failure of contingency expresses differentiation without linkage (typical of avoidance). Each of these leads to defensive exclusion on the part of the child. By contrast, there is no need for defensive exclusion in a context where the various expressions and aspects of the developing self are received in responsive connection; no need to compromise wholeness in order to maintain connection.[62] A third, related feature important for integrated relationship is termed "mentalizing". Mentalizing means relating to another person in light of their own subjectivity, intentions, emotional state, interpretive lens, etc.; and by so doing, supporting them to gain perspective on and make sense of their own experience (Allen and Fonagy, 2002).

Interactions characterized by these three features mirror the child back to herself in a way that communicates that her emotions can be known, expressed, and shared without threatening connection, fostering the development of an integrated self that is distinct from, but at the same time related to, people she cares about. This kind of interpersonal integration defines mature intersubjectivity, which we turn to next.

### 3.3.3. Individuation and mature intersubjectivity

In the first few months, attuned interaction is ideally predominantly characterized by the parent's

[62] This is not to suggest that uninterrupted, perfect attunement is possible or even ideal. On the contrary, disruptions are inevitable and even necessary (see next subsection); what is more important is that they can be recognized and repaired (Wallin, 2007).

responsiveness to the infant. On the foundation thus laid, a more reciprocal, mutual regulation normally develops. However, during her second year, the now-toddler must reckon with the growing recognition of difference. Though more physically and emotionally individuated, the child yet needs connection. The parent's differentiated linkage remains crucial to the resolution of this "rapprochement" stage (Mahler, 1972). As David Wallin writes in his masterful book, *Attachment and Psychotherapy*, "Without the give and take of two distinct subjectivities, the child […] may learn that 'there's only room for one': one voice, one will, one whose needs always dominate, one who controls the interaction" (Wallin, 2007, p. 111). Ideally, though, through the relationship with an attuned, differentiated, and non-controlling parent,

> the child discovers that differences need not be a barrier to shared experience and that dialogue can obviate the requirement that one must dominate and one submit. This discovery allows the child to take fuller possession of his or her own subjectivity, realizing that a relationship can potentially make room for two—two wills, two views of reality, two subjects. (Wallin, 2007, p. 56)

As compared with innate or "primary intersubjectivity", discussed above in the context of protoconversations, this is mature intersubjectivity: not a guaranteed outcome, but a developmental achievement dependent on supportive conditions for its maturation.

### 3.4. Attachment: Summary

This brief overview shows that the quality of early relational experience impacts the developing human's internal working model (IWM; i.e., predictive model of relationship), with impacts on various levels of regulatory dynamics. Insecure attachment is characterized by more or less rigid biases of perception and information processing (e.g., what is salient and how it is appraised, whether it is allowed into consciousness or defensively excluded), whereas secure attachment is characterized by flexibility and lack of bias or defensive exclusion. In other words, abiding regulatory strategies, as well as their rigidity/flexibility, are developed in relationship.

As an infant approaching the uncertain situation of a "visual cliff" turns to its mother to read in her response whether the situation is safe, and thus how to respond to it (Sorce et al., 1985), it appears we also, as infants, receive messages about facets of our inner experience—whether they are safe, and how to relate to them—from the responses of our caregivers.

Having discussed development from a primarily psychological perspective, we now turn to neurobiologically oriented explorations of developmental relationships and their outcomes.

## 4. Biobehavioral synchrony and the neurobiology of attachment

Research into biobehavioral synchrony (BBS) has yielded a wide variety of neurobiological findings relevant to attachment (Feldman, 2017, 2012, 2007). BBS, the interpersonal coordination of biological rhythms, affect, attention, and behavior, shows the various ways in which one body-brain can be connected to another. This coordination is a crucial manifestation of, and support to, the parent-infant attuned responsiveness that facilitates attachment security; as such, measures of BBS have been demonstrated to predict attachment style (Feldman, 2007).

The behavioral element of BBS is the attuned responsiveness ideally seen in protoconversations, including affect alignment, rhythmically coordinated expression, and (as addressed in the next section) attuned touch. As for the "bio" part, mothers and infants who show high BBS coordinate their heart rates, circadian rhythms, and even their brain waves (Feldman, 2012; Wass et al., 2020). Attuned mothers and infants also show coordination in their profiles of oxytocin (OT, associated with bonding), cortisol (stress), and dopamine (reward) (Feldman, 2017).

### 4.1. The "bio" and "behavioral" aspects of synchrony are in dynamic relation

Behavioral attunement leads to synchrony of heart rate, OT levels, and neural rhythms (Feldman, 2017). However, maternal and paternal OT levels during pregnancy and the postpartum period predict the amount and degree of parent-infant interaction synchrony (Feldman, 2012). Further, administering OT has been found to elicit more behavioral synchrony. For instance, intranasal OT administration to fathers increased their touch, play, and exploratory behaviors with their infants, relative to placebo, which in turn led to more infant social engagement and increases in infant salivary OT—over one hundred times the increase observed in control-condition infants (Weisman et al., 2012). Notably, in this experiment, vagal tone (as measured by heart rate variability, HRV; see previous chapter) was higher in both father and child in the experimental group versus control. Thus, OT in one partner influenced autonomic, hormonal, and behavioral activity in both partners.

### 4.2. BBS and child regulation are in dynamic relation

In a further dynamic, synchrony at time 1 predicts child self-regulation at a future time 2, and child self-regulation at time 1 predicts synchrony at time 2, presumably since a more regulated child is easier to synchronize with and/or more capable of synchronizing (Feldman, 2012, p. 45). The positive feedback between child self-regulation and BBS results in potential upward or downward spirals (for resonant findings with adolescents, see Brenning et al., 2015). Underscoring this bidirectional influence, consistent disruptions to protoconversation dynamics, e.g., as in

postpartum depression/anxiety, lead to poorer infant regulation (Feldman et al., 2009)[63]; however, vagal maturity at birth, indexed by HRV, predicts parent-infant BBS (Feldman and Eidelman, 2007) as well as motor, mental, and social skills at 3 years (without accounting for differences in/effects of BBS; Doussard-Roosevelt et al., 1997). These latter kinds of data lead to the conclusion, referred to in the last chapter and to which we will return below, that brainstem-level regulation—particularly that of the vagus—is foundational for the emergence of higher-level (e.g., socio-emotional) regulation (Feldman, 2009).

From these findings, we can begin to appreciate that attuned responsiveness, key for attachment security and the development of healthy self-regulation, simultaneously promotes and depends on a variety of neurobiological correlates. In the next section, we deepen these insights by exploring an aspect of BBS that is fundamentally embodied and relational, with an interoceptive dimension: touch.

## 5. Touch

Touch has a variety of features that distinguish it from other senses. It is the most developed sense at birth (Field, 2010). It is inherently mutual; whereas one can see and not be seen, one cannot touch without simultaneously being touched. As the physical meeting place of self and other, it stands to inform about both (Gentsch et al., 2015; Hertenstein et al., 2009). Additionally, while congenitally blind and/or deaf children can thrive in the absence of visual/auditory stimulation, infants who do not receive affiliative tactile stimulation, even in a context of adequate nutrition, fail to thrive—and often, to survive (Spitz, 1965). Here we investigate some of the surprising features and functions of touch.

### 5.1. Touch as interoceptive-homeostatic

Though the skin is innervated by myelinated mechanoreceptors serving discriminative touch (Aβ fibers, which send signals to the primary somatosensory cortex), there are also nerve types (A∂ and C fibers) that relay signals through a different part of the spinal cord to join visceral information in the interoceptive cortex (Björnsdotter et al., 2009; Craig, 2013). These latter nerves correspond to sensations of itch, temperature, pain, and pleasurable touch. Such sensations carry a motivational valence, as they are relevant to homeostasis (Strigo and Craig, 2016). This homeostatic relevance, combined with their joining visceral interoceptive signals in the posterior

[63] As mentioned, poor synchrony is also sourced in a parent's abiding attachment styles (their patterns of awareness, interpretation, and response), which inhibit their ability to adequately perceive and coordinate with their child (Crittenden, 2017).

insula, indicates that these aspects of touch should be considered interoceptive (Olausson et al., 2010), broadening the definition of interoception as the bodily sense of homeostatically relevant information (Fotopoulou and Tsakiris, 2017). The last chapter focused on the vagus as the primary cranial nerve of interoception; this section addresses one aspect of skin-sourced interoception.

#### 5.1.1. C-tactile fibers

Of interest to us are the unmyelinated "C-tactile" (CT) fibers, which register sensual or affective touch: light stroking at 1-10cm/s (McGlone et al., 2014). These sensory nerves are tuned to the temperature of human touch, with pleasantness ratings and zygomaticus major (smile muscle) activation correlating with CT activation (Ackerley et al., 2014; Löken et al., 2009; Pawling et al., 2017), leading to the assessment that "C-tactile afferents constitute a privileged peripheral pathway for pleasant tactile stimulation that is likely to signal affiliative social body contact" (Löken et al., 2009, p. 1). Additionally, CT-optimal touch has been found to slow infant heart rate (Fairhurst et al., 2014) and increase heart rate variability (HRV) in adults (Triscoli et al., 2017); i.e., CT stimulation recruits the vagus. Thus, there seems to be a supportive relationship between the spinal and the cranial interoceptive pathways.

### 5.2. Touch and the vagus: Affiliative touch stimulates vagal development.

The ventral (myelinated) vagus begins myelinating during the third trimester, and continues to do so through at least the first 9 months postpartum (Pereyra et al., 1992). Pre-term infants demonstrate lower vagal tone (which predicts lower BBS), setting them at a lasting disadvantage (Feldman et al., 2014). However, pre-term infants who were held skin-to-skin for an hour daily by their mothers for the first 14 days postpartum showed better vagal tone, less stress reactivity, and better sleep, cognitive development, and executive function across the first ten years of life, relative to those who received standard incubator care (Feldman et al., 2014).[64]

[64] These effects have multiple mediating factors. For example, massage by a trained therapist yields improved outcomes in pre-term infants, like weight gain (Ferber et al., 2002), and this enhanced weight gain is mediated by increased vagal tone (Diego et al., 2005; Field et al., 2011). [Recall that digestion and growth are supported by the parasympathetic nervous system, i.e., the vagus.] However, if the mother provides the massage, it also supports her OT-release and BBS with her infant (Ferber et al., 2005), as does skin-to-skin holding (Cleveland et al., 2017; Feldman et al., 2014). That is, the relationship between the "bio" and "behavioral" elements of BBS is dynamic: while maternal OT predicts more maternal behavior, touch, and BBS, touch also boosts maternal OT (Feldman, 2012).

Additionally, one may point out that simple skin-to-skin holding is not likely to stimulate the caress-sensitive CT. Interestingly, a review by Vickers et al. (2004) found that dynamic and not static touch is what leads to enhanced infant weight gain. In another investigation, CT-optimal, but not static touch, led to pre-term infant heart rate decrease (Manzotti et al., 2019). The fact that skin-to-skin holding has shown consistent benefits may be explained by the fact that parents (as well as romantic partners) spontaneously caress at CT-optimal rates (Croy et al., 2016). The neural pathways of massage are also varied, involving the interoceptive C and A∂ nerves of the myofascia, not just the skin (Simmonds et al., 2012); perhaps holding (versus static touch) stimulates these deeper layers of spinal interoceptive afferent. These questions warrant further research.

### 5.3. Touch and socio-moral development in childhood

Another set of longitudinal studies investigated the relationship between mothers' attitudes and behaviors of touch on the one hand, and their children's "socio-moral" development on the other (Narvaez et al., 2019). Even controlling for a measure of maternal responsivity, attitudes toward positive touch and corporal punishment each significantly predicted both social thriving and antisocial behavior. In particular, corporal punishment behavior predicted poorer regulation, lower social competence and engagement, and more behavioral problems.

### 5.4. Touch as coregulatory foundation

This chapter so far converges on the conclusion that affiliative touch, attuned responsiveness, and BBS (i.e., the conditions supportive of secure attachment) are foundational for the development of self-regulation and social competence. Such contexts configure physiological settings and organize brainstem-level regulation, which sets the stage for later development. For instance, one study found that affectionate touch in the first 6 months predicted interactive synchrony and reciprocity (mutual regulation) in the second 6 months, even as touch declined (Ferber et al., 2008). Though touch remains an important modality throughout the lifespan (Field, 2010), humans' capacity for affect alignment and even more so linguistic communication allows a wider range of coregulatory strategies, beyond skin and eye contact (Feldman, 2016; Tomasello, 2019). Learning to coregulate with words, however, requires the development of interoceptive experience into symbolic emotional categories. The next section builds on these ideas to examine connections between interoception and relationship.

## 6. Connecting Interoceptive and Relational Predictive Processing

### 6.1. Joint attention supports emotional development

The joint attention of BBS facilitates symbol and language acquisition, which is preceded by the organization of experience into "concepts", i.e., priors. In line with the understanding that objects are more clearly delineated and available for individual familiarizing than are abstract concepts like emotions (Fini and Borghi, 2019), BBS has been found particularly to support the organization of interoceptive experience into emotional concepts, which facilitates emotion regulation (Atzil and Gendron, 2017). Recalling the crucial question of what experiences can or cannot be shared, Roth and Assor (2010) found that kindergarteners whose parents demonstrated non-acceptance of their child's expressions of sadness (i.e., through "parental conditional regard") showed poorer awareness of their own sadness, paired with less ability to identify—and lower empathy for—sadness in others. Recalling the Levels of Emotional Awareness discussed in the previous chapter

(Lane and Schwartz, 1987), we can assess that parents' joining their child's experience facilitates the child's development through those levels of interoceptive sense-making. That is, parents' receptive, engaged attention provides the basis for their child's integrated emotion regulation. (Roth et al., 2019; see previous chapter, section 4.3). Without that kind of joining, development is hindered.

### 6.2. The minimal (foundational) self is inherently embodied and relational

Going further, however, it seems that early touch and BBS are foundational not just to self-regulation, but to the self, itself[65] (Fotopoulou and Tsakiris, 2017). The first experience-based interoceptive priors are formed in collaboration; for example, it is the mother's provision of the nipple in response to her infant's expression of distress that begins through association to form the pre-verbal understanding of the prototypically interoceptive experience we call hunger (Oldroyd et al., 2019). That is, interoceptive predictive processing (IPP) has its foundation in the same context that develops the IWM[66], or what we can call relational predictive processing (RPP). Fotopoulou and Tsakiris (2017) emphasize this inherently embodied and relational context for the development of the self, grounding the concept of mentalizing as always "embodied mentalizing". In their words, "interoceptive inference in development is by necessity mediated by the actions of caregivers that bring about physiological changes, and hence shape the perception of bodily satisfaction, relief, pleasure, pain, or lack thereof" (Fotopoulou and Tsakiris, 2017, p. 19). The minimal self, the core of the experience of selfhood, is shaped through embodied relationality.[67]

### 6.3. Attachment and Interoception

IPP and RPP share considerable overlap, not only in their genesis, but in their outcomes. Noting the essentially somatic nature of the very signals of distress and desire for connection that are allowed, inhibited, or amplified in secure, avoidant, or anxious states, respectively, we should expect to find interoceptive idiosyncrasies associated with attachment styles. For instance, given that a key characteristic of avoidant attachment is the inhibition of awareness of one's attachment system signals, we may hypothesize that avoidance will be associated with poor interoception. On the anxious pattern of hyperactivation, in parallel with the interoceptive pattern of anxiety discussed in the previous chapter, Mikulincer and Shaver note the strategy of heightened sensitivity to interoceptive cues of distress, including "hypervigilant attention to the physiological

[65] This can be considered the experiential correlate of the early neurobiological organization.
[66] Indeed, given that it is a relational predictive model, the IWM has always been theorized as of both the other and the self, particularly "how acceptable or unacceptable he himself is in the eyes of his attachment figures" (Bowlby, 1973, p. 203).
[67] For a nightmarish account of the fragmented mode of consciousness that can result from severe neglect, see (Fonagy and Allison, 2016).

aspects of emotional states" (Mikulincer and Shaver, 2019, p. 7).

A recent pair of studies investigated these connections (Oldroyd et al., 2019). In the first study, scores on an assessment of attachment style were compared with scores on a measure of interoceptive sensitivity, the Multidimensional Assessment of Interoceptive Awareness (MAIA, Mehling, 2016). The MAIA's various subscales indicate attentional and appraisal styles as relate to interoception. Unsurprisingly, attachment anxiety was associated with increased noticing of bodily sensations paired with increased worry about them. Further, avoidant attachment was associated with decreased capacity to sustain attention to the body, and less trust in the body as safe and in its signals as reliable (Oldroyd et al., 2019).

Following from reports that people who are avoidantly attached show a disconnect between their physiological arousal and their expression (e.g., Borelli et al., 2014), the second study investigated the relationship between a mother's (self-reported) acceptance/rejection of negative emotion in their adolescent, and the latter's concordance between self-reported distress and a physiological measure of arousal (skin conductance response, SCR). Consistent with attachment theory's predictions of avoidance, maternal rejection of negative emotion was negatively related to congruence between the adolescent's self-report and SCR (Oldroyd et al., 2019).

Like Fotopoulou and Tsakiris (2017), Oldroyd and colleagues emphasize the social origins of interoception, making the connection between the parent's mentalizing—allowing the child to see their own subjectivity accepted and reflected in their parent's way of relating to them—and the inherently embodied nature of that subjectivity.

## 7. The Vagus, Safety, and Social Engagement

The last chapter suggested the activity of the vagus, in association with the prefrontal cortex's (PFC) inhibition of the amygdala, is an important determinant of regulatory dynamics (e.g., Thayer and Lane, 2009; Thayer and Sternberg, 2006). Adding the important social context, it is also clear that "absence of positive social interactions early in life, especially those involving physical contact with caregivers, helps set a low threshold for activating the amygdala in response to potential threats that may persist throughout the lifespan" (Ochsner and Gross, 2007, p. 103). That is, the lack of an attuned and accepting social context disrupts the development of the vagally-coordinated psychophysiology of safety.[68]

In one demonstration of this attuned-caregiver/child-PFC connection, preschool children

[68] Note the parallel with the "setting" of the stress response documented in rodents, based on the amount of "licking and grooming" the pups receive (Meaney, 2001).

in the presence of their mothers showed heightened inhibition of the amygdala by the PFC, facilitating enhanced emotional and behavioral regulation (Gee et al., 2014). Importantly, these effects were greatest for the more securely attached children. Relatedly, as mentioned above, attachment insecurity is associated with HPA dysregulation (e.g., T. Kidd et al., 2013). These findings are consistent with the idea that high-quality social contexts foster a non-defensive biobehavioral orientation, likely mediated by the development of high vagal tone.

As discussed in the previous chapter, sympathetic/amygdala activation is associated with perception of danger, whereas parasympathetic/PFC predominance is associated with perception of safety. In addition, it seems that a physiology of safety supports social engagement. Underscoring this connection, CT-optimal touch, in addition to slowing infant heart rate (via the vagus), has also been found to stimulate infant social engagement, e.g., increasing gazing behavior (Fairhurst et al., 2014). Further, as mentioned, vagal tone at birth predicts parent-infant BBS, supporting the conclusion that "brainstem-mediated systems that support homeostasis and arousal modulation provide the basis for higher order social regulatory capacities" (Feldman, 2012, p. 44). Connecting with the consistent finding that attachment security portends higher quality relationships, we see here another dynamic of mutual reinforcement. Receiving well-attuned social attention, through touch, marked affect alignment, and mentalization, supports vagal activity and development; at the same time, vagal activity and development support *participation* in higher quality social connection.

### 7.1. The social engagement system

The close association of the myelinated vagus with other cranial nerves involved with facial expression, eye contact, and vocal communication, with either overlapping origin in the brainstem, spatially continuous innervation, or shared/collaborative function (Butler and Hodos, 2005 Chs. 10-12), forms what Porges calls the "social engagement system" (Porges, 2011; Porges and Lewis, 2010). The rapid modulation of affective expression in attuned face-to-face exchange, the "prosody" (sing-song quality of voice) characteristic of "motherese" vocalizations, and the tuning of the eardrum to frequencies of human speech are all served by this system. Notably, these very styles of communication (responsive face and prosodic speech, as well as CT touch) seem to elicit a physiology of safety, receptivity to vocalization (tuning the eardrum), and social engagement generally (Porges and Lewis, 2010).

Thus, while a primary response to danger or stress is to turn to one's attachment figures, the motivation to connect is not simply reactive (Ryan and Deci, 2017). We are also intrinsically, spontaneously motivated toward social engagement in modes of safety—and the vagus is central

to both sociality and safety. In contrast, misattuned, controlling, or non-responsive relating—and, as we turn to next, loneliness or lack of belonging—leads to defensive psychophysiology and autonomic dysregulation, which can in turn challenge social interaction.

## 8. Sociality throughout the lifespan

After presenting current understandings of the evolved human need to be in connection with other humans, this section discusses some of the impacts of disconnection.

### 8.1. Evolution: Social by nature

Humans are evolved for group life (Haidt, 2012), for connection (Feldman, 2016), and to be integrated in a social network of meaningful, collaborative relationships (Coan and Sbarra, 2015). We are naturally cooperative and prosocial.[69] In studies comparing chimpanzees to human infants, the competitive experimental paradigm used with chimps did not work with human infants and had to be shifted to a cooperative paradigm (Moll and Tomasello, 2006). Other experiments show that infants spontaneously help strangers (Hepach et al., 2017; Warneken, 2013); this intrinsic motivation is somewhat undermined if rewards attempt to reinforce it (Warneken and Tomasello, 2008; for review of rewards undermining intrinsic motivation, see Deci et al., 1999). Uniquely among primates, we have prominent white sclera that advertise where we are looking, a phenotype hypothesized to have evolved in a context of trust and cooperation (Kobayashi and Kohshima, 1997). Squarely countering accounts of human nature asserting only competitive and instrumental relations, humans are innately motivated toward, and intrinsically rewarded by, the alignment of attention, affect, and intention (Feldman, 2017; Morelli et al., 2014; Tomasello, 2019).

### 8.2. The human baseline is social integration

With this evolutionary history comes the widely acknowledged need for belonging (e.g., Baumeister and Leary, 1995). Expanding on attachment theory and synthesizing a variety of findings, "social baseline theory" articulates within a PP framework that the human organism

[69] In line with the understanding of evo-devo and this chapter as a whole, this human tendency requires supportive contexts for its maturation. Maturation implies that such a tendency does not require that it be explicitly trained. Indeed, as this paragraph notes, attempting to do so can backfire. For humans, joint intentionality and prosociality are the normal baseline (see below), and they are intrinsically rewarding. That is to say, prosociality is the primary orientation, but it is dependent on supportive conditions. Without them, secondary, self-protective (and self-dividing) strategies tend to be utilized instead (e.g., insecure attachment)—or in sufficiently overwhelming circumstances, collapse/dissociation (e.g., disorganized attachment)—with negative consequences for well-being. These secondary strategies are clearly also evolved aspects of our nature; the emphasis on the primary is not intended to deny the reality of the full range of humans' adaptive repertoire, but to explain its differential expression. Cf. neurobiologist Narvaez et al.: "those who develop with sub-optimal care will be more likely to be stress reactive and move into self-protective moral orientations in social situations, whereas those whose care is closer to optimal will be well-regulated and likely to engage prosocially with others" (Narvaez et al., 2019, p. 3). See also footnote 61.

expects social relationships that include interdependence, joint attention, and joint intentionality (Beckes and Coan, 2011; Coan, 2016). That is, humans are adapted to and dependent on co-regulation (Coan and Maresh, 2014). Absent these conditions—i.e., outside the bounds of this evolved relational prior—hills seem steeper, stressors are more stressful, threats are more threatening, and pain is more painful (Coan, 2016; Coan et al., 2017; Coan and Sbarra, 2015; Krahé and Fotopoulou, 2018; Oishi et al., 2013). The resulting physiology (see below) leads to a higher death rate than those who are socially integrated (Holt-Lunstad et al., 2010). In other words, without meaningful relationship, life really is "nasty, brutish, and short" (Hobbes, 1651). In contrast to Hobbes's notion of it, the "state of nature" is not an individualistic "war of all against all", but of trusting, affiliative collaboration with other humans. This is a deep evolutionary prior, outside the parameters of which we accumulate significant allostatic load (see section 2.1 of previous chapter).

### 8.3. Physiological impacts of social disconnection

Social disconnection exceeds obesity, smoking (up to 15 cigarettes a day), and lack of exercise as among the strongest lifestyle-related predictors of all-cause mortality (Holt-Lunstad, 2017; Holt-Lunstad et al., 2017, 2010). Mediating physiological factors include poor sleep quality, autonomic dysregulation, glucocorticoid receptor resistance (GCR), inflammation, and cardiovascular disease (Cacioppo and Patrick, 2008; Cole, 2013; Uchino et al., 2018).

Specific epigenetic changes in immune system regulation occur due to chronic loneliness or lack of social safety, termed the "conserved transcriptional response to adversity" (CTRA)—upregulation of proinflammatory genes and downregulation of antiviral genes (Cole, 2013; Cole et al., 2015, 2007). The evolutionary explanation for CTRA is that when socially integrated, it makes sense to orient the immune system to viruses (which are generally socially transmitted); whereas in situations of social disconnection, it was adaptive for our ancestor's immune systems to prepare against the threat of bacterial invasion due to potential wounding through conspecific or predator attack (Eisenberger et al., 2017). Even so, those with high quality social ties show accelerated wound healing (Kiecolt-Glaser et al., 2005; cf. Detillion et al., 2004).

### 8.4. From physiological to psychosocial: increased threat sensitivity, impaired PFC

Inflammation, as we've seen, leads to changes in sensitivity to reward/threat that can lead to depression – and indeed, loneliness predicts the development of depression, not vice versa (Cacioppo et al., 2010, 2006; Qualter et al., 2010). Consistent with the PNS-PFC connection—according to which a physiology of threat compromises the PFC's executive regulatory function (e.g., Thayer et al., 2009)—rejection, loneliness, etc., have been found to lead to worse

performance on GRE questions, tests of attention, and measures of self-control (Cacioppo and Patrick, 2008; see also Layden et al., 2017).

#### 8.4.1. Defensive social orientation

One aspect of the complex psycho-socio-physiology of loneliness is increased attention to, expectation of, and thus perception of, negative social information, and social threat in particular (Cacioppo and Hawkley, 2009; Cacioppo et al., 2016; Layden et al., 2017), with a corresponding increase in avoidance motivation (Gable, 2006). However, while one of the elements of "sickness behavior" prompted by inflammation is social withdrawal, another is to seek out safe social support (Eisenberger et al., 2017). In keeping with this, both affiliative and avoidant responses to exclusion have been documented (Powers and Heatherton, 2012)[70]. As an example, one affiliative response observed among the excluded is increased conformity (e.g., Williams et al., 2000). Which kind of response is expressed is likely to be moderated by expectations of support availability (i.e., by IWM); unfortunately, such studies generally do not test for association with attachment style. Still, what is most emphasized in the loneliness literature is a defensive orientation that (consistent with the idea of the vagally coordinated social engagement system) leads to decreased empathy and more negative social interactions (e.g., Cacioppo and Patrick, 2008; Hawkley and Cacioppo, 2010). We return to this self-perpetuating dynamic in section 10.

### 8.5. Regulatory impacts of relationality are pervasive (not just in development)

This section has shown that social connection is such a deeply important context for human existence that outside the bounds of that evolved homeostatic prior (i.e., not being socially integrated in networks of meaningful relationships), there are predictable alterations to gene regulation and psychophysiological processes, leading to poor health and well-being outcomes—and further challenging social connection. The question remains, however: what defines connection? The next section synthesizes various perspectives towards an answer to this question.

## 9. Social Disconnection and Social Connection: What makes the difference?

Regulatory consequences of social disconnection have been studied in a variety of ways. It is beyond the scope of this thesis to extensively parse, critique, and make sense of the various experimental paradigms and measures in this field. However, a sampling will help to elucidate the

[70] I note here my skepticism of the validity of equating present exclusion with "future exclusion". In the latter type of experiment, accurate personality test feedback builds confidence in the tests, preceding the news that a participant (generally a college student) is the kind of person who, regardless of how socially connected they are now, will nevertheless end up alone. This should be expected to be particularly demotivating, since it implies that they have no control over the outcome (Deci and Ryan, 2000); therefore, such credible and damning prophecy should be expected to undermine affiliative and prosocial motivation, which is indeed what is found.

basic elements of connection: that is, what kinds of relationality lead to well-being versus ill-being.

### 9.1. Measures of dis/connection are largely siloed

Following Holt-Lunstad's (2018) categorization, there are three broad classes of measures: structural/objective (e.g., social network analysis), functional/subjective (e.g., loneliness), and quality/intersubjective (e.g., relationship satisfaction). Each of these measures as they exist broadly in the literature tend to correlate not necessarily with each other, but with health and well-being outcomes (Holt-Lunstad, 2018). The measures' relations to each other have not been often studied; however, connections have been drawn (e.g., Hawkley et al., 2008; Uchino, 2009).

#### 9.1.1. Bridging with attachment theory: IWM impacts all three categories

##### 9.1.1.1. Social networks

Gillath and colleagues (2019) note that, though Henderson (1977) long ago pointed out the relevance of attachment to social network dynamics, those studying the latter have rarely included the former. Gillath et al.'s research has shown that attachment styles contribute to network dynamics over time. For instance, as might be expected, attachment avoidance is associated with the dissolution of social ties over time (Gillath et al., 2017).

##### 9.1.1.2. Subjective

One of the most commonly studied measures in the second category is perceived social isolation (PSI), or simply, "loneliness" (Cacioppo and Patrick, 2008), as distinct from more objective measures of isolation, e.g., via social network analysis. A person's relative stability of PSI across varied actual circumstances of one's social network makes sense in light of the IWM; i.e., it is due in large part to the quality of early relational experience (Collins and Feeney, 2004; Uchino, 2009).

##### 9.1.1.3. Intersubjective

Adult attachment as a field of relational study has been criticized for its focus on "individual differences"—i.e., attachment style as a stable personality trait rather than an ongoing dynamic (i.e., relational) process (e.g., Sbarra and Hazan, 2008). The wider shift to the study of attachment *dynamics*, not simply as a personal trait but as an evolving process subject to various relational partners' attachment styles, is relatively recent (Kobak and Bosmans, 2019), though the critique was articulated some time ago (Kobak, 1994). One such study found, for instance, that higher cardiovascular reactivity during couple conflict is predicted by one's *partner's* anxious attachment (Ben-Naim et al., 2013).

#### 9.1.2. Past and present: Actual dynamics matter

The perception of social support is colored by the expectation of its availability; these expectations are sourced partly in early experience, but importantly, they are also sourced in experience with a

particular relationship. That is, the actual relational dynamics (e.g., presence/lack of attuned responsiveness) are a real factor. Self-determination theory (SDT) has pointed this out as a critique of general attachment studies for some time, demonstrating significant within-person (i.e., between-relationship) differences in attachment security, mediated by the need-supportiveness of their relational partner (La Guardia et al., 2000). Further studies have shown the actual characteristics of relational dynamics to impact the amount of support perceived, willingness to emotionally disclose, reports of relationship quality and satisfaction, and resulting well-being (Roth et al., 2019; Ryan and Deci, 2017, Ch. 12).

That being said, we can surmise that, similar to IPP, the more toward the pathological end is one's RPP, the less sensitive it is to expectation-disconfirming particulars of relational realities (i.e., the more rigid the predictive model) (Kobak and Bosmans, 2019). Indeed, flexibility of processing and response is noted as a marker of healthy attachment; to be able to accurately read social signals and respond accordingly is adaptive. In normal circumstances, predictions do influence one's perceptions and behaviors, but importantly (some might say obviously), partners play a role in that dyad's dynamics and associated outcomes.

### 9.2. Further siloes: Bridging connection and disconnection

Much of the work on social disconnection has been disconnected, itself, from fields of study that would inform better theory and assessment of what meaningfully constitutes connection or quality (Feeney and Collins, 2015; Uchino, 2013), leading to the curious phenomenon of "studies on relationships devoid of theories about relationships" (Gillath et al., 2019, p. 24). Consequently, studies in that field seldom investigate the quality of social support[71]. This factor is important because poorly attuned, intrusive, degrading, debt-inducing, or otherwise sub-optimal support provision tends to be experienced as disconnective (Feeney and Collins, 2015, p. 121).

#### 9.2.1. Attachment theory and attuned responsiveness

Bridging these gaps, some researchers have built on insights from attachment theory to argue that

[71] "Most of the empirical work linking relationships to health and well-being conceptualizes social relations in terms of individuals' general reports of their marital status, social networks, social integration, and perceived social support …[In general,] researchers have not considered specific dyadic behaviors or interaction patterns that underlie the effects of social relations on health and well-being, or the mechanisms through which these effects occur" (Feeney and Collins, 2015, pp. 113–114). For instance, though marriage is a predictor of greater longevity, the predictive value is greatly heightened when relationship quality is taken into account. And yet the way that is done is often via self-report, e.g., of satisfaction, commitment, or whether one confides in their spouse. In its relationship to PSI, marriage to a non-confidant is the same as not being married (Hawkley et al., 2008). But commitment to the relationship can be dissociated from quality (as closeness and satisfaction), as in "relationship-contingent self-esteem" (Knee et al., 2008). As compared with self-reports, "microlevel" observations of relational dynamics (similar to those used in protoconversation and interactive synchrony analysis) may well be more predictive of relevant outcomes (Graber et al., 2011; Smith et al., 2011).

the elements that are most connective and characteristic of "quality"—i.e., most predictive of well-being—are the same as those that support secure attachment in infancy: namely, attuned responsiveness (Feeney and Collins, 2015; Pietromonaco and Collins, 2017). They emphasize both the "secure base" and "safe haven" aspects of attuned responsiveness, supporting explorative and growth drives as well as providing comfort and co-regulation in times of stress. This focus on the importance of partner responsiveness to the sharing of both positive and negative events (e.g., excitement at having succeeded, discouragement at having failed), and of supporting goal-achievement, is echoed by others in the field of relationship science (e.g., Reis, 2014).

#### 9.2.2. Self-determination theory and autonomy-support

As mentioned above, the well-being enhancing and detracting elements of relationships have been studied within SDT's framework of basic psychological needs. In that line of research, autonomy-support emerges as a crucial element of what supports well-being (via satisfaction of all three basic needs: autonomy, relatedness, and competence). When people are autonomy-supportive,

> They respect the other's perspective, display interest in and care about the other's feelings, and generally take an accepting or experience-validating stance toward the other. They are open and listening. […] By minimizing pressure, autonomy-supportive agents promote a sense of initiative and choice, which enables others to act in nonconstricted and exploratory ways […], with curiosity and with less defensiveness (Roth et al., 2019, p. 951).

Such features of autonomy-support resonate strongly with attuned responsiveness. In particular, the centrality of taking the other's internal frame of reference and acknowledging their feelings and desires, which allows them to feel understood (Ryan and Deci, 2017, p. 306), bears striking resemblance to the concept of mentalizing. Indeed, autonomy-supportive parenting predicts secure attachment (Frodi et al., 1985)[72], as well as the myriad positive outcomes associated with it (e.g., Bernier et al., 2010; Perry et al., 2019).

#### 9.2.3. Mutuality and "room for two"

SDT indicates that high quality relationships are those that are autonomy-supportive, but also, that the highest quality relationships are mutually so, resonating with van der Kolk's emphasis on "reciprocity: truly hearing and being heard; really seeing and being seen by other people" (van der Kolk 2014, p.354). This converges with the idea of mature intersubjectivity, a description of which is quoted at length:

> Such [mutual] recognition is fundamental to an "intersubjective" as against an

[72] In the Frodi et al. study, autonomy-support was an even stronger predictor of secure attachment than the utilized measure of maternal responsiveness.

> "intrapsychic" experience of others. The first depends on our perceiving the other as a separate subject who *primarily exists outside our mental field of operations*. The second involves our responding to the other primarily through projection, identification, and other intrapsychic processes—in which case the other is *essentially an object in our representational world*, to be idealized or devalued, perhaps, but not experienced as a real person. In the terms of Martin Buber's (1923/1970) "interhuman" philosophy of dialogue, intersubjective relatedness makes for an "I–Thou" relationship marked by mutuality, dialogue, and *the ability to experience others in their own terms*. By contrast, intrapsychic relating confines us to an "I–It" relationship in which mutuality is absent, imposition supersedes negotiation, and *preexisting categories dominate our experience* of other people (Wallin, 2007, p. 55, emphases mine).

Note the connection of RPP to the dynamics highlighted by this quote. The intrapsychic corresponds to the superimposing of the predictive model's priors onto our experience of others, whereas the intersubjective indicates a stronger weighting of the bottom-up pathway. We will return to RPP in section 10. For now, we turn to the "I-It" model of imposition and control, as contrasting mutuality and autonomy-support.

### 9.3. Control as autonomy-thwarting

The mutuality of the above quote is in stark contrast to the research paradigm of "repeated social defeat", which is sometimes used to study PSI in rodents—though the phenomenon is quite different from isolation. A mouse has bigger, more aggressive mouse is dropped into its cage each day for 6 days. As a result, the dominated mouse develops CTRA (see section 8.3) and other stress responses like those seen in human PSI (Powell et al., 2013; Weber et al., 2017). Repeated social defeat brings to mind a tyrannical boss (or mean teacher), and indeed, work environments are clearly tied to health and well-being outcomes. For instance, in the Whitehall studies of health across work hierarchies, the amount of control employees had over their work (i.e., degree of autonomy) was the strongest factor in predicting coronary heart disease (Bosma et al. 1997).

Deci and colleagues (1981) surveyed teachers prior to the start of the school year in order to assess their motivational styles via responses to hypothetical child behavioral problems. For instance, a controlling teacher would typically endorse a punishment or reward to control behavior, whereas an autonomy-supportive teacher would try to understand the child's experience and work with them to find a solution. Already by 2 months into the school year, the students of teachers who were strongly autonomy supportive and strongly controlling showed significant differences in intrinsic motivation, perceived competence, and self-esteem. In another iteration of that study,

the investigators compared students during the first week and at two months, finding divergence from baseline in both directions, depending on teacher motivational style, with control detrimental and autonomy-support beneficial (Deci et al. 1981).

As we've just suggested, such effects are not limited to children in the classroom; similar results have been found in the workplace. Deci, Connell, and Ryan (1989) adapted the Deci et al. classroom study to assess managerial motivational styles, finding that more controlling managers fostered a workplace climate in which workers felt more alienated. In addition, they reported lower job satisfaction and were more motivated by pay (i.e., they were less intrinsically motivated).

### 9.4. What is connective? Conclusions

Controlling modes of relationship do not respect or connect with the experience and intentionality of the other, and instead instantiate a dominating "I-it" pattern of interaction. They are therefore *disconnective*, i.e., *less integrated*, leading to lower well-being. The mentalizing, "I-thou", autonomy-supportive mode, on the other hand, supports well-being because it fits the homeostatic priors of joint attention and joint intentionality for which humans are evolved.

That is, isolation is just one form of disconnection, like neglect is one form of pathogenic context. Hostility, intrusiveness, defensiveness, judgment, control, and otherwise unsafe modes of relationship can also lead to a wide variety of poor outcomes, as compared to those characterized by warmth, attuned responsiveness, mentalizing, and self-disclosure.

Based on the reviewed streams of study, it seems that autonomy-supportive, mentalizing, attuned-responsive relationships, characterized by joint attention and joint intention, are those that are most connective, high quality, and supportive of well-being, via their support of integrated, non-defensive functioning. As van der Kolk suggests, "Being able to feel safe with other people is probably the single most important aspect of mental health" (Van der Kolk, 2015, p. 81). We will return to this idea in the discussion chapter.

We next turn to put the topics of this chapter more explicitly into the predictive processing (PP) framework, connecting to some of the themes from the previous chapter.

## 10. Updating vs. replaying the model: Prediction error minimization in RPP

Recall that in PP, the implicit goal of the system is to minimize prediction error (PE), and that there are three basic ways to do so. One option corresponds to attentional and interpretive biases that enforce the top-down dominance of the prior expectation in perception. The inverse (bottom-up) option, termed "perceptual inference" (e.g., Farb et al., 2015), is to allow new data to update the model. The third option, "active inference", is to act in such a way as to create the

circumstances that match the model. Much of what is described in the literature addressed in this chapter corresponds to the first option. That is, an insecure internal working model (IWM) entails to greater or lesser degree the dominance of expectation in the construal of events. I here address the other types of PE minimization: perceptual and active inference.

### 10.1. Perceptual inference: interoception, mindfulness, and social connection

In relational as in interoceptive predictive processing, perceptual inference is crucial for updating crude and overly defensive models. This is the principle behind "attachment-informed psychotherapy" (Holmes and Slade, 2017) and other approaches bridging attachment theory to psychotherapy (Wallin, 2007): to get relief from the problems caused by attachment insecurity, the IWM must be updated. This requires putting more weight on present experience (see previous chapter, section 3.1). That is, as in perceptual interoceptive inference, the role of open attention to present moment experience (i.e., mindfulness) is key. Of special importance is embodied awareness: accessing and integrating the aspects of experience that have been excluded from awareness (and which have thus remained undeveloped) often begins with noticing, and staying present with, their bodily elements (Fogel, 2013; Wallin, 2007).

#### 10.1.1. Interoception and social connection

Arnold et al. (2019) report that they have found qualitative measures in the MAIA (multidimensional assessment of interoceptive awareness) to be negatively correlated with loneliness, in particular the "body trusting" subscale—the same as with avoidant attachment (Oldroyd et al., 2019). Relations between interoception and social exclusion have also been documented: better interoception apparently buffers against feelings of exclusion (Werner et al., 2013, 2009); at the same time, social exclusion has been found to decrease cardiac interoceptive accuracy (Durlik and Tsakiris, 2015). Supporting this latter finding, participants exposed to angry faces showed decreased heart-evoked potential (HEP), indicating less cortical processing of cardiac signals (Marshall et al., 2018). This suggests that social threat, which the lonely and insecure are primed to perceive, has negative impacts on self-sensing.

#### 10.1.2. Mindfulness supports social connection

Mindfulness, which has a strong interoceptive component, is the best treatment so far studied for loneliness (Lindsay et al., 2019). Arnold et al. (2019) note that the increased interoceptive ability may account for a large part of the decrease in PSI symptoms. However, the cognitive dimension may well help, from the top down, to loosen the rigidity of the IWM (decreasing the precision of the priors) while at the same time increasing the precision-weighting of the bottom-up.

A less-popularized practice of mindfulness is of special relevance here. Langerian (or socio-

cognitive) mindfulness brings present-moment awareness to deliberately perceive novelty, create new categories, and take into account multiple perspectives (Langer, 1989; Khoury et al., 2017). As such, it is precisely suited to the task of updating priors and making a more nuanced and flexible model. One's interaction partners benefit, as well, from this kind of presence (Langer et al., 2012). Mindfulness in those around us seems a key element for "being truly seen and known", accepted non-judgmentally—versus ignored, rejected, or treated instrumentally.

Outcomes of mindfulness practice show remarkable parallels with those of attachment security (Shaver et al., 2007). Mindfulness in oneself is key to integrated, non-defensive functioning (Brown et al., 2007; Brown and Ryan, 2003) and lends itself to a reflective as opposed to reactive stance toward our experience, which supports the ability to mentalize both ourselves and others (Wallin, 2007). That is, mindfulness supports social connection.

### 10.2. Active Relational Inference

Crucially, the relational predictive model is shaped by, but also shapes, interaction. While a few researchers have drawn the connection between attachment theory's IWM and PP's predictive model (e.g., Coan, 2016; Fotopoulou and Tsakiris, 2017), or even created computational, Bayesian models of attachment style formation (Cittern et al., 2018), these generally address only the passive element of the dynamic: i.e., the construction of the model, rather than its causal influence. Others have highlighted the need for perceptual inference as therapeutic update to the model (Holmes and Slade, 2019). However, though the dynamics have been variously identified, no one to my knowledge has investigated or theorized, in a PP framework, the active inference mode of PE minimization for relationship: i.e., how circumstances are actively brought in line with the relational model's predictions. I thus take the opportunity to point out some of the ways this occurs, and in doing so, emphasize both the causal influence of RPP and the surprising permeability of, or resonance across, the boundary between self and other.

Wallin (2007) provides a basis for understanding this active nature of the insecure IWM. He explains that unintegrated experiences (emotions, intentions, etc.) exist in an implicit, unverbalizable mode, unavailable to conscious reflection. In this implicit mode, they are, however, still active parts of the organism's operating system—the problematic nature of which is generally what motivates the seeking of therapy (cf. Smith and Lane, 2016). These unintegrated experiences can be either embodied, evoked, and/or enacted.[73]

[73] Compare this with the first two levels of emotional awareness, before the emergence of explicit emotional awareness: emotion as somatic sensations and as action (Richard D Lane, 2000). Missing from that treatment, however, are the intersubjective processes of evocation and enactment.

#### 10.2.1. Resonance and evocation

A partial explanation for the active inference mode of RPP is in the activity of "mirror neurons". These are neurons, present in a number of different brain regions, that fire when we either perform or observe an intentional action, helping us to simulate and resonate with the states and motives of others in our own bodies (Gallese, 2014). Humans are particularly sensitive to facial expressions—even when we are unaware of having seen any faces at all. When participants, in the context of viewing a neutral video, were exposed to 30-millisecond splices of angry or sad faces, changes in their micromusculature reflexively mirrored the expressions they unconsciously saw (Dimberg et al., 2000). Paul Ekman, the leading expert on facial phenomenology and physiology, emphasizes that faces not only express emotions; they also activate them. Further, he believes the "music" of the voice evokes a similar kind of activation, enabling us to feel the resonance of others in ourselves (Ekman 2003, cited in Wallin 2007). That is, just as a relaxed, prosodic tone of voice can communicate and coregulate a vagally-organized psychophysiology, various kinds of tensions and timbres in the voice can evoke the gamut of feeling-states.

Further, and perhaps more mysteriously, what is evoked can be a part of the IWM that corresponds to the self *or* an internalized role of another ("concordant" or "complementary", Racker, 1968). In the latter case, the role's externalization into an unwitting resonator sets up the conditions for enacting the scripts written in the IWM.

#### 10.2.2. Enactments and provocation

As Freud had identified the "repetition compulsion", Bowlby noted the "self-perpetuating quality" of IWMs (Bowlby, 1980). Noting the intersubjective facets of this repetition, psychoanalytic theorists have frequently attested to the ways in which maladaptive relational patterns are played out, or "enacted" in the context of the therapeutic relationship. That is, the occurrence of reinforcing experience is not just due to biases in attention, interpretation, and memory (though this is a real factor), but is actually elicited from others through subtle or not-so-subtle means. Confirmatory experience in RPP is "not only construed but constructed: Clinical experience confirms that patients frequently behave in ways that elicit confirmation of their particular interpretations of interpersonal reality (Aron, 1996; Gill, 1983; Mitchell, 1993; Renik, 1999a, 1999b)" (Wallin, 2007, p. 176).[74]

[74] This is theorized, at its root, to be fundamentally the same process (albeit generally more "sophisticated" and disorienting), as when an infant communicates (transfers) her overwhelming states nonverbally to the parent, who ideally contains, processes, and gives back to the infant her own state (i.e., regulating the dysregulated), allowing it to be integrated. That is, where that ideal scenario was not realized, the process still seeks completion (Wallin 2007).

#### 10.2.3. Active relational inference in loneliness

PSI researchers have identified both construal and construction in loneliness, noting the "self-fulfilling confirmation biases" and the "'regulatory loop' through which loneliness perpetuates itself" (Hawkley and Capitanio, 2015, p. 2). This loop is described in the following quote emphasizing active participation on the part of the lonely:

> Lonely individuals also tend to form more negative social impressions of others, and their expectations, attributional reasoning and actions toward others tend to be less charitable than shown by nonlonely individuals. When an individual's *negative social expectations elicit behaviors from others that validate these expectations*, the expectations are buttressed and increase the likelihood of the individual behaving in ways that pushes away the very people to whom he or she most wants to be close to better fulfill their social needs. Consequently, lonely individuals may view themselves to be passive victims in their social world, but they are active contributors through their self-protective and paradoxically self-defeating interactions with others (Cacioppo and Hawkley, 2009, p. 452, emphasis mine).

#### 10.2.4. Contagion

Fascinatingly, these authors also discuss the spread of loneliness through social networks (i.e., its contagion), noting three potential mechanisms: their negativity and defensiveness impacting the quality of interactions, automatic emotional contagion, and "coextensive self–other overlap and the attendant susceptibility of shared states" (Cacioppo and Hawkley, 2009, p. 452).

This thesis cannot explore the mechanisms, complexities, and nuance of how these self-other overlaps, evocations, and provocations occur; it must therefore suffice to simply indicate that they do. In addition, though a thorough treatment would require multiple theses, I must minimally acknowledge the importance of considering the wider social contexts in which immediate relationships are embedded (Holt-Lunstad, 2018).

## 11. Wider Social Contexts

The contagion of loneliness connects with an idea suggested by much of this chapter: that the prevailing levels of attachment security, vagal tone, social competence, etc., of those around us may tend to draw us into similar states, with profound impacts on our own prospects for health and wellness. Clearly, having many social ties with people guarded against intimacy is not as *connective* as interactions with unguarded and supportive people, who are able to take the other's perspective, not objectifying, comparing, etc. But what happens if there are too few unguarded and attuned people; i.e., if one's actual social context is bereft of opportunities for connection?

### 11.1. Loneliness as a cultural context

In the US context, for instance, social connection in the latter half of the 20th century showed steep declines (Putnam, 2000). Additionally, in a pair of surveys, the number of people that respondents reported they could confide in declined between 1985 and 2004; troublingly, the most frequent response dropped from three to zero (McPherson et al., 2006). The outcome of these trends of fraying social networks have led some to declare an "epidemic of loneliness" (Will, 2018). The impacts of such a widespread cultural phenomenon of loneliness are likely many and profound. It has for instance been connected to the increasing polarization of society (Sasse, 2018). I have previously argued that this disconnection-driven tribalization has contributed to an "epistemological crisis" (cf., climate denial), wherein shared ideology serves as a meager substitute for belonging, heresy risks excommunication from the group, and we therefore rationalize whatever is required to maintain membership (Adams, 2018; cf. Haidt, 2012; Kahan, 2013).

### 11.2. Economic context

If we are interested in a political philosophy of well-being, it will be instructive to understand the ways that current societal institutions interact with and obstruct processes of well-being. I here limit the discussion to a brief mention of two interrelated topics of particular interest to ecological economics.

#### 11.2.1. Inequality is pathogenic

A wide disparity between rich and poor decreases trust, heightens comparison, and stimulates defensive social orientations (Wilkinson and Pickett, 2011). Wilkinson and Pickett (2011) use a variety of epidemiological data to demonstrate that inequality within a society is correlated with many kinds of ills: physiological, psychological, and social. They attribute much of this to a heightened sense of social evaluative threat, which prompts defensive functioning, attempts to prove our worth or avoid shame, and the concomitant compulsion toward managing others' perceptions of us, as well as our own self-conception relative to others. Such "materialistic values" of *image* and *status* are anathema to the authentic self-disclosure and autonomy-supportiveness characteristic of connection (Kasser, 2002), and yet they become more prominent motives in a society as inequality increases.

#### 11.2.2. Materialistic values have an inverse relationship to well-being

Numerous studies of the impacts of materialistic values and pursuits have found them to be antagonistic to well-being, associated with lower life satisfaction and vitality, more anxiety and depression, and a variety of other adverse outcomes (Kasser, 2002; Kasser et al., 2004). On an

individual level, developmental contexts lacking safety and connection are associated with higher levels of materialism, underscoring the secondary, compensatory nature of materialistic aims (Kasser et al., 2004). Further, having a "materialistic values orientation" is correlated with lower quality relationships, characterized by more of an "I-It", Machiavellian relational orientation (treating others as means to an end), and in general more antisocial attitudes and behaviors—as well as more somatic symptoms (Kasser et al., 2007). Noting the causal relationship, a set of longitudinal studies (one of which involved an experimental intervention) found that changes in level of materialistic values orientation predicted changes in well-being (Kasser et al., 2014).

Therefore, beyond each of their independent contributions to ill-being, these three elements—inequality, materialism, and loneliness—seem to reinforce each other in downward spirals of ill-being. Namely, inequality exacerbates materialism, and both stand to reliably increase loneliness (e.g., via decreases in trust and increases in defensive and antisocial behavior); on top of that, loneliness reinforces itself, in individuals and through social networks.

This short section simply aims to acknowledge that humans exist in cultural contexts, and that the forms these contexts take impact well-being dynamics in important and characteristic ways (see, e.g., Ryan and Deci, 2017, Chs. 22-23).

## 12. Conclusion

Self-regulation is developed and maintained in the context of relationship. Interoception is likewise developed in relationship and strongly impacted in an ongoing way by social experience. Particular relational dynamics strongly influence both self-sensing and self-regulatory dynamics in characteristic ways throughout the regulatory hierarchy: from executive to limbic and autonomic function, even impacting gene regulation. One direct way interoception is affected is through affectionate touch: a relational-interoceptive modality that supports vagal activity. Crucially, early experience of attuned, responsive caregiving is associated with a psychophysiology of safety. The capacity for non-defensive social engagement thus instilled serves later relationships.

Drawing from a number of theories, it seems that the relationships that are the most connective and supportive of growth, regulatory capacity, and well-being throughout life are, similarly, those characterized by attuned responsiveness and autonomy-support, allowing partners to feel accepted, joined, understood, and supported.

Further, in contrast to some prominent streams in the history of Western thought, humans are evolved for cooperation and prosociality: to share attention and intentions. Our primary orientation is to affiliate, bond, and co-regulate. If these evolutionary priors and motives are not

supported, defensive psychophysiology and allostatic load are the result, which can be self-perpetuating and difficult to break out of.

Noting the importance for our own well-being of whether we have access to relational partners who can interact authentically and intersubjectively with us (rather than defensively with the intrapsychic expectations of their internal working model), and acknowledging the influence of cultural and political-economic factors on that availability, this chapter begins to suggest a *collective* understanding of well-being. That is, our WB is profoundly influenced by the WB of the people around us, and by the modes of relationship that are the norm in a cultural context. We will return to this idea in Chapter 7. First, the next chapter adds another dimension: the well-being collective of which we as individuals are part is wider than the solely human community.

# Chapter 6 – Terrestriality

## 1. Introduction

The basic thesis of this chapter is that disconnection from the more-than-human world is associated with dysregulation and dysfunction (physiological, psychological, and social). I start by noting some of the evolutionary basis for the impacts of non-human nature on humans, highlighting the topophilia hypothesis. According to this hypothesis, we are evolved to bond to local place; without that connection, we will likely not thrive. The chapter focuses, however, not on the important question of emotional bond and subjective relationship to nature, but on the more basic question of whether the presence or experience of non-human nature has beneficial regulatory impacts. I focus, in turn, on physiological, psychological, and social impacts, finding the answer to be yes for all three. I then come full circle back to the body, pointing briefly to the burgeoning research on the wide-ranging impacts of the more-than-human within us: the microbiome. Our existence—our very *being*, as well as our well-being—is profoundly interwoven with the rest of life on this planet.

This chapter features less new theory than the other chapters, as much of the framework for understanding the ideas presented here has already been constructed. Thus, this chapter mainly presents the results of studies on the influence of non-human nature on people's health and WB outcomes, connecting them to the regulatory dynamics discussed in the previous chapters.

## 2. Evolution

Environmental conditions other than those to which a species is adapted are likely to be less supportive of healthy development and function. Where the last chapter noted these "innate priors" in relation to humans' social experience, this chapter poses that the same holds true for the more-than-human context of our existence. That is, the human organism is tuned and motivated toward particular ranges of experience, outside of which it will accumulate allostatic load.

The most well-known idea associated with humans' evolved propensity toward "nature" is E. O. Wilson's (1984) *biophilia hypothesis*. According to this idea, since humans evolved in savannah environments, we likely have an innate affinity for such settings. And indeed, there is some evidence that "people have a generalized bias toward savannah-like environments" (Orians and Heerwagen, 1992, p. 560). However, the biophilia hypothesis has some problems (Kahn, 2011, Ch. 2). Kahn notes, for instance, that it is not actually a scientific hypothesis, given that it is not "predictive, testable, and open to disconfirming evidence" (p. 18). Another issue is that the affinity is to more than just the "bio" aspects of nature, encompassing land (terrain, rocks, and sand), water

(rivers, lakes, and oceans), and atmosphere (the sky, qualities of the air, and weather). In addition, beneath his poetic language, Wilson's framework is in fact quite reductionist (Kahn, 2011, Ch. 2).

Sampson (2012) responds to these and other problems associated with the biophilia hypothesis with the *topophilia hypothesis*, according to which our ancestors' evolutionary success was enabled by having affective bonds to *place*. Citing the Late Pleistocene context of both episodic climatic upheavals and the spread of human populations over all the continents but Antarctica, Sampson poses that *topophilia*, "an innate tendency to establish affective bonds with local nature" (Sampson, 2012, p. 32) would have fostered the acquisition of detailed, place-based knowledge essential to survival in novel and changing environments (i.e., not just savannahs).

Though it is important not to presume that today's indigenous peoples are unchanged from 50,000 years ago, commonalities across surviving foraging cultures may well be representative of ways of living that were adaptive for all of our forebears. And indeed, as Sampson writes, "an intimate relationship with place or land, encompassing both landscape and life forms, is one of the most salient features of indigenous cultures" (Sampson, 2012, p. 35). As an expression of that intimate relationship, one highly notable characteristic of foraging communities is their extensive knowledge of staggering arrays of local species.

In describing his experience with the Fore people of New Guinea, Jared Diamond (1999) emphasizes their impeccable knowledge of the ecological community of which they were part. He notes that ethnobotanists report similarly astounding knowledge from traditional peoples elsewhere, even though "all such peoples either practice at least some food production or are the partly acculturated last remnants of the world's former hunter-gatherer societies. Knowledge of wild species was presumably even more detailed before the rise of food production, when everyone on Earth still depended entirely on wild species for food" (Diamond, 1999, p. 144).

This knowledge seems, importantly, to be rooted in a relationship of a different sort than that of the western botanist or zoologist (Kimmerer, 2013), or of the instrumental, extractive type typical of economic orientations. That is, the relation is not *I-it* (using Buber's terminology as mentioned in the previous chapter), but *I-Thou*, "at once practical and spiritual" (Grim, 1993). Living systems have their own proactive nature; they are not mechanistic. That is, such systems are not simply acted upon; they are responsive. Those attuning and adapting to this feedback as active participants, differentiated and linked, thus enhance their integration in the system. As so eloquently put by Abram,

> For the largest part of our species' existence, humans have negotiated relationships with every aspect of the sensuous surroundings, exchanging possibilities with every flapping

> form, with each textured surface and shivering entity that we happened to focus upon. All could speak, articulating in gesture and whistle and sigh a shifting web of meanings that we felt on our skin or inhaled through our nostrils or focused with our listening ears, and to which we replied—whether with sounds, or through movements, or minute shifts of mood. The color of sky, the rush of waves—every aspect of the earthly sensuous could draw us into a relationship fed with curiosity and spiced with danger. Every sound was a voice, every scrape or blunder was a meeting—with Thunder, with Oak, with Dragonfly. And from all of these relationships our collective sensibilities were nourished.
>
> Today we participate almost exclusively with other humans and with our own human-made technologies. It is a precarious situation, given our age-old reciprocity with the many-voiced landscape. We still need that which is other than ourselves and our own creations. (Abram, 1996, p. ix)

The presence of non-human nature is a basic prerequisite for relationship with it, particularly in childhood. Consistent with the topophilia hypothesis, kids appear universally to prefer natural spaces (Adams and Savahl, 2017), though the expression of this tendency is under siege from a variety of trends (Louv, 2008). The topophilia hypothesis predicts that without the bond to place, humans will have poorer mental health, and that this relationship is particularly important in childhood development. The evidence reviewed in this chapter supports this prediction.

Thus, having been an important part of human evolution, an intimate relationship beyond the merely human is likely still an important part of human development. Without it, we may be underdeveloped in consequential and unrecognized ways (Shepard, 1982). However, due to the influence of a reductionist worldview, such an intersubjective relationship beyond the confines of the species is so far lost to the culture at large that we seem to view it as a form of superstition (Abram, 1996). The deficiency in this dimension of relationship may well be part of an explanation for our culture's disorientation, its widespread mental illness, and its wanton destruction of the basis of life (Abram, 1996; Scofield and Margulis, 2012).

Very much in line with this chapter's findings, a recent assessment (Baxter and Pelletier, 2018) found strong evidence that nature relatedness meets the criteria for basic psychological need (see footnote 10). Much as we saw with social relationships, the quality of that relatedness is likely impactful beyond the mere presence of nature. However, this thesis must largely leave that question to other work (see Zylstra et al., 2014). This chapter focuses on evidence that simply being in the presence of the more-than-human world has profound impacts on human functioning.

After noting some of the basic ways this has been studied, we address physiological, psychological, then social effects (which, as we've seen, influence each other powerfully).

## 3. Common research methods

Existing scholarship on the influence of non-human nature on people's health and WB has not settled on standardized definitions or classifications of the types of nature to be studied. The US Center for Disease Control has defined "green space" as "open, undeveloped land with natural vegetation"[75], but studies generally include street trees, city parks, etc., in their analyses. I know of very few studies that attempt to compare the effects of different kinds of natural landscapes, and I reflect on some questions about this in the discussion below. There is also a growing literature on "blue space", i.e., water, but in the current synthesis I focus on the presence of general greenspace and studies of its influence. Another limitation of scope is that connection with other animals is not treated (for review, see Beetz, 2012).

Studies of the effects of greenspace exposure use correlational as well as experimental methods. Of the correlational studies, many use satellite data to assess the amount of greenspace within some radius of a residence (or sometimes a school). The studies using such measures, operating at this coarse level, will miss many important variables[76]. For instance, the degree of accessibility is not included: whether the greenspace is private or public, differential child/adult accessibility, etc. Further, whether or how often people actually access greenspace (or whether children's parents allow them the freedom to do so on their own) cannot be determined from satellite data. Such mediating factors may explain sometimes contradictory results (e.g., Lee et al., 2019; Weeland et al., 2019a). We can expect more reliable results from studies that use more individualized data (Weeland et al., 2019b).

Partially responding to the issue of accessibility, Rugel and colleagues (2017) propose a method that takes into account whether greenspace is private or public. In addition, their "natural space index" appraises the quality of parks. The researchers found that adding these considerations yields very different results as compared with the basic method. Another study compared various satellite methods (and distance thresholds for inclusion) with residents' self-described neighborhood boundaries (Reid et al., 2018). The greenness of the self-defined neighborhood area was the better correlate of the target variable (self-rated health, in this study). This is presumably because the descriptions correspond to the area in which most time is spent.

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[75] Definition available at www.cdc.gov/healthyplaces/terminology.htm

[76] They are thus subject to some of the same issues as national correlational studies of subjective well-being (SWB, see Chapter 2).

Overall, there is considerable heterogeneity in methods, which some meta-analyses have cited as challenging the ability to draw clear conclusions (e.g., Gascon et al., 2015). Complementing these correlational studies, however, there is also a range of experimental studies. Some take participants into forests, others into parks, and still others simply expose participants to images or sounds of natural settings, comparing these conditions to urban or indoor settings.

## 4. Physiological effects

Several recent reviews indicate the numerous benefits to physical health and longevity associated with greenspace exposure (Gascon et al., 2016; Hansen et al., 2017; Ives et al., 2017; Kuo, 2015; Twohig-Bennett and Jones, 2018). For instance, a recent meta-analysis (Twohig-Bennett and Jones, 2018) of over 140 studies (40 of which were experimental) concluded that numerous measures of health are significantly improved by exposure to greenspaces including heart rate, heart rate variability (HRV; see Ch. 4, Sec. 2.3.1), blood pressure, and cortisol levels. In addition, the occurrence of all-cause mortality, type II diabetes, and other illnesses and poor health outcomes was found to be reduced with increased exposure to non-human nature.

In a set of 24 studies contrasting the effects (relative to baseline) of 30 minutes of walking in and looking at forest versus urban settings (Park et al., 2010), the forest condition yielded decreased cortisol, heart rate, and blood pressure (indicating decreased sympathetic nervous system [SNS] and HPA activity), and increased HRV (indicating increased parasympathetic [PNS] activity). This is the physiological profile of healing and rest, rather than defensive activation. After longer periods, forest-walkers show a higher white blood cell count, as well as more adiponectin and DHEA, which are cardio-protective and lower the risk of both obesity and diabetes (Li et al., 2011). DHEA, additionally, has anti-cancer and anti-inflammatory properties, and fascinatingly, low levels of it are indicative of attention deficit disorder (ADD; Wang et al., 2011).

Such findings corroborate those of pioneering studies in the field. In one such study, Ulrich (1984) investigated the recovery outcomes of hospital patients with windows facing either a brick wall or a more natural view, finding the greener view to be associated with faster recovery from surgery.

The various physiological measures surveyed here all play roles in the dynamics discussed in Chapter 4. Given the interconnections between these dynamics and psychological processes, we should not be surprised to find similar regulatory benefits in the psychological realm.

## 5. Psychological effects

### 5.1. Mental health

Engemann et al. (2019) tracked greenspace within a 210m x 210m square around Danish children's homes over the first 10 years of their lives and found that children with the least exposure had a 55% greater likelihood of developing mental illness later in life. The effect was only partially explained by the effects of greenery on air quality. Even after controlling for social-economic factors, parents' history of mental illness, and other variables, the effect remained significant for nearly all of the mental illnesses assessed.

At least some of these protective effects of the more-than-human world are likely due to the "buffering" effect that non-human nature can have in times of stressful life events. A study of 337 rural children assessed in-home "naturalness", child life stressors, parent-rated child distress, and a measure of child-reported self-worth (Wells and Evans, 2003). The researchers found that those children with more "natural" yard, views from the home, and interior space (i.e., having indoor plants) had lower distress and higher self-worth than children with a similar stressor profile but less natural elements in and around the home. That is, the more-than-human seems to increase children's resilience in the face of major perturbations.

In line with the Engemann et al. study noted above, a study using data from nearly 2,500 Wisconsin adults found greenspace to correlate with less depression, anxiety, and stress (Beyer et al., 2014). Further, greenspace in the Netherlands is associated with lower rates of antidepressant prescriptions (Helbich et al., 2018).

### 5.2. Attention and executive function

A number of studies have found the more-than-human to enhance attention and executive function in children (Dadvand et al., 2015; Lee et al., 2019; Mårtensson et al., 2009), particularly those diagnosed with ADD (Faber Taylor and Kuo, 2009; Kuo and Faber Taylor, 2004). For instance, when children with ADD were taken for walks in a neighborhood versus in a natural setting, the nature condition had effects comparable to that of ADD medication (Faber Taylor and Kuo, 2009).

The studies of enhanced attention and executive regulation lend support to the more general attention restoration theory (ART; Kaplan, 1995; Kaplan and Berman, 2010), which poses that being in or exposed to nature boosts executive function, directed attention capacity, and processes of reflection. Executive control, e.g., as utilized in tasks of effortful mental activity, is subject to fatigue[77] (Muraven and Baumeister, 2000); ART holds that the presence of nature helps in its

[77] This phenomenon is now debated after some prominent replication failures (see Inzlicht et al., 2014). Part of the explanation may be, as self-determination theory (SDT) research has shown, that this phenomenon is limited to the relatively *controlled*, less integrated forms of regulation, whereas the same activities autonomously engaged can even enhance vitality, i.e., energy available for purposive action (Nix et al., 1999). That is, self-control (doing something because we feel compelled to) is draining, but self-organization (autonomous regulation; doing something volitionally, because we value it) is not (Ryan and Deci, 2008).

recovery. Part of this proposal is that natural features engage attention effortlessly (i.e., they are "fascinating"), without being so stimulating as to crowd out reflection (i.e., they are "soft"). The pleasantness associated with the "soft fascination" of natural stimuli is additionally proposed to ease the pain of reflecting on serious topics (Herzog et al., 1997).[78]

Taking advantage of a "natural experiment", Kuo (2001) compared outcomes at low-income housing projects. Buildings were identical in layout, with randomly placed tenants from the same walks of life, but with one key difference: some buildings had a preponderance of concrete where others had grass and trees. Residents at the nature-impoverished sites had more difficulty managing their lives; they reported "more procrastination in facing their major issues and assessed their issues as more severe, less soluble, and more longstanding than did their counterparts living in greener surroundings" (Kuo, 2001, p. 1). That is, those with less non-human nature were more dysregulated and more dysfunctional. As we see next, these effects also bear on social interactions.

## 6. Social effects

Green space supports social connection. In the same housing projects mentioned just above, tenants at the greener sites knew each other and had supportive social networks; by contrast, residents at sites with less greenery reported more aggressive interactions (Kuo and Sullivan, 2001a). Police reports confirmed the disparity; the latter sites had over twice as many violent crimes (Kuo and Sullivan, 2001b). A more recent study in the UK also found neighborhood greenery to correspond to more social cohesion and less crime (Weinstein et al., 2015). Yet another study of neighborhood blocks in Baltimore, Maryland found that tree canopy cover was correlated with more connected social networks (Holtan et al., 2015). Further, a study of over 10,000 people in the Netherlands found green space to negatively correlate with loneliness (Maas et al., 2009).

As part of a potential explanation for these correlations, experimental evidence suggests that the more-than-human promotes prosociality (Weinstein et al., 2009). In a set of experiments, participants were exposed to natural or urban stimuli and had their aspirations assessed for fame and wealth (extrinsic aspirations), and for relationships and community (intrinsic aspirations). Those in the natural condition reported significantly more motivation for the latter, prosocial aims. In another experiment in the same study, participants were given a choice to be generous at some potential cost to themselves. Those placed in rooms with live indoor plants were found to act in a

[78] Such reflection is recognized by SDT as key for the development of integration and self-organized/autonomous function, but SDT associates it primarily with mindfulness. However, SDT researchers also note the benefits of non-human nature, particularly as relates to enhanced vitality (Ryan et al., 2010)

more generous and trusting manner than those in rooms without plants (Weinstein et al. 2009).

## 7. Findings in context

The previous chapters provide a basis for making sense of these diverse effects. We have seen the profound and pervasive dynamics of mutual influence between physiological, psychological, and social processes, and that higher-level regulatory capacities are supported by the integrity and function of the lower ones. Given the strong support for the basic physiological/autonomic regulatory benefits of natural environments, attention restoration theory (ART) and the other psychological effects fit into the framework of the neurovisceral integration model (Thayer and Lane, 2009), in which parasympathetic (i.e., vagal) activity supports the engagement of the prefrontal cortex (PFC). Recalling the two-way supportive relationship between the vagus and social engagement, the evidence of the more-than-human's prosocial influence and enhancement of community cohesion also fits into the organismic-eudaimonic framework being developed here. This chapter extends this framework's emphasis on interconnected dynamics of various levels of function to include the ecological.

The emphasis on "greenery" in the existing literature raises the question of the effects of less-green landscapes, like winter in deciduous zones, and deserts. Of the many particular qualities that provide the particular benefits of nature experience, some are physical/discrete entities (soil bacteria, molecules released by trees, atmospheric ions produced by running water, etc.; Kuo, 2015); ostensibly, natural environments that have less of these will have a concomitant drop in benefits. Other aspects, like the "soft fascination" of sights and sounds, are less able to be pinned down. Potentially, as compared to a mountain forest or the vast expanse of the great plains, a desert landscape—harsher, more austere, though no less awe-inspiring—may evoke a different set of responses: physiologically, psychologically, and socially. Perhaps such a difference contributes to the patterns of cultures found in lush locales versus drier regions (see Sapolsky, 2005; Botero et al., 2014). These questions are left for future work.

Predictive processing is applicable here, as well. As an example, in "modern" cultures, we can more or less ignore the trees. If the differences between species do not seem pertinent to our lives, our perception remains underdeveloped. For hunter-gatherers, a well-developed, discerning, and attuned predictive model of the non-human world is not elective. In animal tracking, for instance, heightened sensory precision is essential: the bend of a twig, a scratch on the bark, the depth of a hoofprint—all of these cues have meaning for one who has attuned to their more-than-human landscape (e.g., Liebenberg, 1990; Nelson, 2020). Further, there is evidence that this

increased attention is associated with increased WB: in one experiment testing the effects of different levels of awareness of trees, those who gave explicit attention to the trees showed the most restorative effects (Lin et al., 2014).

And of course, beyond immediate experience and its broadly health-supportive impacts, we depend on the functioning of ecosystems for everything from food and flood control to a stable climate and the "opportunity to be able to achieve what an individual values doing and being" (Millennium Ecosystem Assessment, 2005). Societies that overshoot their context's carrying capacity undermine the conditions that support them and eventually collapse (Diamond, 2011; Tainter, 1988). We will return to this idea in the next chapter; here we briefly address a miscategorization prevalent in related discourse.

### 7.1. Ecosystems regulate humans, too

A common framework used to refer to the ways that ecological processes support human life and society is that of "ecosystem services".[79] This framework categorizes ecological functions into 4 types: supporting (e.g., nutrient cycling, soil formation), regulating (e.g. regulating climate, disease, flooding), provisioning (e.g., food, fiber), and cultural (recreation, "spiritual values"). Within this framework, the value of spending time in nature would be considered a cultural service. The implicit message is that the benefits derived are a matter of arbitrary, personal, aesthetic preference. The evidence reviewed here, however, suggests that time spent in nature is better categorized as *regulating*. The presence of the more-than-human has a profound *regulatory* effect on human organisms and the interactions between them. Intriguingly, as we see next, these profound regulatory effects of the more-than-human are not limited to the external ecology.

## 8. The more-than-human within

Of the cells within the boundary of the human skin, those with human DNA are far outnumbered by those that comprise the microbiome. Even the human cells, and indeed all eukaryotic cells, are the result of an ancient symbiosis, carrying within them mitochondria (and for plants, chloroplasts) that have their own bacterial DNA and divide via binary fission (Kutschera, 2018). Further, the skin itself is a landscape of varied ecosystems (Schommer and Gallo, 2013) populated by viruses,

[79] The ecosystem services framework has been criticized for its "foundational commodity logic" (Dempsey and Robertson, 2012) of *I-it* relations, often lending itself to the translation of nature's functions into dollar amount (as in Costanza et al., 1997). See also Norgaard (2010) for how the framework blinds us to the complexity of our situation. In line with this thesis, though beyond its scope, a growing number of scholars point beyond the dichotomy of instrumental value (for human benefit) and intrinsic value (for its own sake) to relational values (Chan et al., 2016; Muraca and Himes, 2018).

bacteria, archaea, fungus, and arthropods (specifically, mites). Many of these members of the skin community participate in bidirectional influence with the immune system, with some known to play a role in both the development and regulation of immune function (Byrd et al., 2018; Schommer and Gallo, 2013; Wanke et al., 2011). These complex interactions are in further relation with the microbiomes of the lungs and gut (Thomas and Fernández-Peñas, 2017).

The human gut is populated by a wide variety of organisms (Rowan-Nash et al., 2019), including bacteria, archaea, viruses, fungi and other unicellular eukaryotes, and sometimes animals (helminths). These microbiota not only play a key role in digestion; they also have numerous effects on the regulatory dynamics of the organism itself. I here briefly mention a few of these.

Organisms within the gut impact both neural and blood-borne interoceptive signals, e.g. via immune and endocrine systems (Cryan and Dinan, 2012; Clarke et al., 2014). Gut microbiota produce neurotransmitters identical to those produced by "our own" cells (Butler et al., 2019). Impressively, their activity has been shown to impact gene expression in the amygdala, hippocampus, and prefrontal cortex of the mouse (Bravo et al., 2011). Alterations of the gut microbiome have also been found to lead to abnormal development of the HPA axis (Sudo, 2014).

It is presumably through such varied channels that the microbiome impacts behavior. In mice, fecal transplant leads to the recipient's behavior becoming more like that of the donor (Bercik et al., 2011). When rats were given fecal transplants from humans with depression (as opposed to from healthy controls), they developed depressive behavioral patterns (Kelly et al., 2016). Further studies with mice suggest that particular bacterial species can restore impaired oxytocin regulation, reduce anxiety-like behaviors, and enhance social interaction (Bharwani et al., 2017; Buffington et al., 2016; Hsiao et al., 2013). Through these and other complex pathways, *dysbiosis* (dysregulation of the microbial community) is associated with a variety of diseases and syndromes in humans, including irritable bowel syndrome, depression, and autism (Allen et al., 2017; Butler et al., 2019).

One cause of dysbiosis is disconnection from the outer more-than-human world. Chronic inflammation, contributing to both physical and psychiatric illness, is on the rise in high-income countries. This is due in part to "failing immunoregulation, attributable to reduced exposure to the microbial environment within which the mammalian immune system co-evolved" (Hoisington et al., 2015, p. 2; Raison et al., 2010). This explanation bolsters Kuo's (2015) identification of immune regulation as a key medium for beneficial impacts of nature exposure, and further drives home the interconnectedness of human well-being with both inner and outer ecology.

In this section's brief foray, we come full circle to the body, finding that the more-than-

human *within* impacts the gamut of what this thesis has discussed in terms of regulatory function: gene expression, autonomic function and interoceptive signaling, development and regulation of the immune system and HPA axis, psychological function, and behavior and social interaction.

## 9. Conclusion

Humans appear to have an innate affinity toward the wider natural world. Even if this is not consciously recognized, valued, or acted upon, the evidence reviewed here strongly suggests that non-human nature has health-promoting and prosocial effects on humans. That is, the more-than-human world enhances self-regulation and co-regulation. Further, the human being shares a long evolutionary history with myriad organisms with which we are co-constituent, which participate in our being and well-being. The activity and ecological regulation of those organisms is deeply interwoven with the rest of our being's regulation. That is, not only our well-being, but our very being itself, is inseparable from the vast complexity of other beings and ecological processes within and around us.

# Chapter 7 - Discussion

## 1. Overview

This chapter reflects on the findings and themes of the preceding chapters. A central theme is that integration (differentiated linkage of a system's parts) underlies the healthy, adaptive regulation characteristic of well-being (WB). The assessment and synthesis of the wide array of literatures cited in this work strongly suggests that, beyond material sufficiency, the most important factors for WB are attentional, collective, and mutualistic, rather than consumptive, individual, and rival. A further idea emerging from the framework developed in this thesis is that the capacity for non-defensive functioning may be considered the hallmark of human WB; importantly, however, that capacity is a developmental achievement dependent on supportive conditions.

This thesis, focusing on *whole-person health*, (i.e., organismic-eudaimonic WB) is the first part of a research agenda aiming toward an understanding of *whole-systems health* (i.e., whole-systems well-being; WSWB). In this chapter, I therefore take advantage of the opportunity to point to the far-reaching relevance and applicability of the organismic-eudaimonic framework introduced in this thesis, outlining some of the next steps in this research agenda and identifying other promising avenues for future research.

## 2. What is Well-being?

This thesis set out to discern a coherent understanding of WB. Here, I highlight some of the themes that emerged in exploring the phenomenon of WB. A primary theme, introduced in Chapter 2 as a guiding premise, found support throughout the main chapters: *integration* is the basis of WB. Another theme is the role of non-defensive *awareness*—i.e., the capacity to attend flexibly and openly to various aspects of experience—in achieving integration and WB. This recognition contrasts the consumptive approach to WB inherent in the dominant societal model. Further, reflecting on the interconnected dynamics of WB processes and outcomes leads to the conclusion that WB is best considered as *mutualistic* and *collective*, rather than rival and individual.

### 2.1. Integration

The three main chapters of this thesis concern the quality of relationship with each of three basic elements of the human situation, considered as ranging from disconnection (of varied kinds) to *integration*: differentiated linkage of system parts, characterized by attuned responsiveness. For each element—embodiment, sociality, and terrestriality—the picture that comes into view is one in which integration promotes health and well-being, and in which disconnection is associated with varying degrees of dysregulation and pathology.

The chapter on embodiment discussed the role of non-defensive attention in developing accurate interpretations of interoceptive/emotional signals. This attunement to the body and its signals is the foundation of adaptive responsiveness, i.e., the adoption of behavioral and self-regulatory strategies that are based on well-calibrated assessments of internal and external conditions and that are effective in achieving goals. Of particular importance to hedonic conceptions of well-being (as well as eudaimonic), the experience of emotion is rooted in interoception, and thus the integration and regulation of emotion depend on attuned awareness of the body. Poor sensing of interoceptive/emotional signals appears to be implicated in depression. Poorly calibrated interpretation of these signals appears to be at least partly responsible for anxiety, addiction, and eating disorders. Failure to process and integrate interoceptive/emotional experience appears to be the definition of PTSD. Broadly, then, the quality of relation to the body most supportive of health and WB is that it attends to sensory inputs, differentiates and interprets them accurately, and responds accordingly—i.e., a relation of attuned responsiveness.

That is, regulation depends on the organization of experience into meaningful categories, with corresponding physiological and behavioral action flowing in accordance with this *predictive model*. When the system is *integrated*, the top-down predictions are attuned and responsive to the bottom-up sensory signals, rather than imposing crude categories despite relevant distinctions. This integration allows for flexible, context-appropriate responses. The success of these responses in turn supports a predictive model of the self as effective at managing its interactions with the world. Since such a self is less easily threatened, this further yields a non-defensive orientation, characterized by autonomy and capability. In contrast, poorly calibrated models default toward defensive orientations (Brosschot et al., 2015), which are associated with poorer outcomes in a wide variety of dimensions.

With regard to the second element, sociality, the relationships and interactions that people experience as most connective are those characterized by joint attention and joint intentions, in which people feel understood and supported. These modes of relationship, differentiated and linked, attuned and responsive, are the social conditions most supportive of human development, health, and WB. As described by attachment theorist and clinical psychologist David Wallin:

> Healthy relationships of attachment, especially in the first years of life, are necessary for the development and integration of [regions of the brain]. Such integration ensures that the various capacities of the brain—sensory, motor, emotional, analytical, and so on—can be functionally linked to make possible the most coordinated and adaptive use of all of the brain's potential resources. (Wallin, 2007, p. 78)

Interpersonal neurobiologist Dan Siegel emphasizes the profundity of this revelation:

> Integrated relationships stimulate the growth of integration in the brain. Integration in the brain is the basis, so far as we can tell from all the existing research, of self-regulation at the heart of well-being and resilience. How we regulate our emotions, thoughts, attention, behavior, and relationships is dependent on integrative fibers of the brain. (Siegel 2017, p. 82) [80]

The chapter on our earthly context did not review empirical evidence pertaining to the quality of the relationship with the more-than-human, though it discussed highly plausible theory indicating that intimate bonds of connection with one's local ecology are likely those most supportive of development, health, and well-being. At minimum, exposure to natural vs. built settings has a broad and multi-system regulatory effect on the human organism and on social dynamics. Thus, integration within the brain-body system, with other humans, and with the non-human world appears to be core to human WB.

### 2.2. Attention

In all of these relationships—with body, others, and our non-human kin—attention is a common element in building a well-calibrated predictive model, forging connection, and achieving WB. Mindful attention also supports the neural integration mentioned in the quotes above. Attention directs neural activity and is a key driver of *neuroplasticity*, redirecting and reinforcing neural pathways (Schwartz and Begley, 2009). A truism in neuroscience, formulated from the work of Donald Hebb, is that "what fires together wires together".[81] Accounting for the role of attention in this process, and having also made the link to relational dynamics, Siegel reformulates and extends the truism: "Where attention goes, neural firing flows, and neural and interpersonal connection grows" (Siegel, 2018). That is, both intra- and interpersonally, non-defensive awareness—receptive, nonjudgmental, non-controlling—promotes integration. Though we reviewed less on this topic as regards the non-human, the role of attention shows up there, too (e.g., Lin et al., 2014). Thus, attention appears to be a basic resource for integration and WB.[82]

#### 2.2.1. The consumption assumption

The strong evidence of the role of attention in achieving WB establishes a robust counterpoint to the notion that WB is a matter of consumption. Indeed, it would be difficult to argue that

[80] Note that when Siegel uses the term "brain", he is referring to a fully embodied (not just enskulled) phenomenon.
[81] This handy quip was coined by Carla Shatz (1992). Another related aphorism of hers is "out of sync, lose your link" (reported in Siegel, 2012, p. 197).
[82] In a conceptual link to the integrative function of attention, the word "attend" comes from roots meaning "to stretch toward".

consumption (beyond a comfortable, secure sufficiency; see footnote 11) serves such a function of increasing integration. Thus, in contrast to the "consumption assumption" inherent in neoclassical economics' approach to WB (see Ch. 2, section 5.1), this thesis suggests that human WB is more fundamentally a matter of attention.

### 2.3. Mutuality

Further, WB processes seem to be mutualistic, rather than rival or antagonistic. Both within and between levels of organization, systems display amplifying and stabilizing dynamics. These dynamics can entrench modes that are integrative and health-promoting, or those that are fragmenting and pathogenic.[83] As emphasized above, integration underlies WB: the differentiated linkage of the system's parts is what allows the system to self-organize, self-regulate and stay adaptive, flexible, and coherent. However, less-integrated modes of system operation can also have self-regulating, self-perpetuating, and self-propagating dynamics, though they are less flexible (Thayer and Lane, 2000). This is true for humans (Fredrickson, 2013; Thayer and Lane, 2000), relationships (as in the intergenerational transmission of attachment style), social networks (as in loneliness contagion), as well as ecosystems (Whisenant, 1999).

We have seen many examples of such dynamics in the preceding chapters. For instance, amygdala activation may inhibit the prefrontal cortex (PFC), generating habitual reactivity and sympathetic activation. Especially when chronic, this activation can lead to upregulation of proinflammatory immune response and immune cells primed for glucocorticoid receptor resistance, which is an aspect of HPA axis dysregulation. The resulting chronic inflammation has numerous psychophysiological impacts: for instance, changing mood, motivation, and threat sensitivity. This can impact social dynamics, increasing defensiveness and decreasing empathy. Less self-disclosure and more management of others' perceptions is disconnective and less authentic, potentially leading to persistent feelings of isolation. Such a resilient mode of loneliness can spread through a social network. On the other hand, when the parasympathetic stays online, or with mindful awareness, the PFC is more likely to regulate the amygdala. In this circumstance, there is more flexible access to all of the brain's resources. Social interactions flow more smoothly, further reinforcing vagally coordinated (i.e., more integrated) states.

As the above quotes from Wallin and Siegel attest, neurological integration (objective),

[83] In the broader realm of systems, such modes, with their own dynamic stability, are often referred to as alternative stable states or "attractors". One way of conceptualizing this is to picture a surface with depressions or basins of varying width and depth (e.g., Scheffer and Carpenter, 2003). A ball (depicting the current system state) can be knocked around on that surface but will tend to return to the "local minimum" of a particular basin of attraction. That is, there is some degree of resilience to that mode of the system, with thresholds that need to be surmounted in order to shift into a new mode. (In such depictions, a shallower basin denotes less resilience.)

psychological integration (subjective), and relational integration (intersubjective) are mutually reinforcing, intertwined aspects of the process/phenomenon of WB. These cross-domain dynamics attest to the pervasiveness of mutuality in processes of integration and WB. For instance, an integrated relationship with the body is developed and supported by integrated relationships with other people. Prosocial, non-defensive relationship with others is, in turn, supported by the integrated self-regulation that results from non-defensive, attuned relationship with the body. The presence of non-human nature promotes both healthy psychophysiological regulation and greater social engagement and sense of community. Thus, processes of WB seem to be generally *mutualistic*, in both WB-promoting and WB-obstructing ways, at whatever level of analysis (i.e., regardless of the scale of focus in the emergent system dynamics)—*and between* levels of analysis.

#### 2.3.1. Rivalry

This mutualism is in stark contrast to the rival, antagonistic relationships assumed by neoclassical economics (NCE), whether between humans or between humans and the planet. Rivalry, in economic terms, means that my having a thing precludes or inhibits your having it: it is a zero-sum game. WB, on the other hand, is not rival; and neither is it simply non-rival, wherein my having it would have no effect on others' prospects. It is additive (cf., Kubiszewski et al., 2010): my having it *enhances* others' prospects. By the same token, however, my having low levels of WB works against others' prospects for WB.[84]

### 2.4. WB as a collective phenomenon

This discussion thus points to another important conclusion: WB is not a solitary affair. Its

[84] One may raise the question of status as a zero-sum factor in SWB: relative standing in income brackets (as opposed to absolute income) has been found to correlate with SWB (see the Easterlin paradox; Easterlin et al., 2010; Smith, 2014). A sketch of a response follows. First, it should be pointed out that this is further evidence against the consumption assumption; i.e., beyond sufficiency (see footnote 11), it is not the money or consumption that matters, but the comparison. Second, the striving for status (through the materialistic values of image, fame, and wealth) is an extrinsic aspiration (Kasser et al., 2004), counter to (and compensation for the lack of) experiences that actually foster WB—not comparison and competition, but authenticity and competence, connection and collaboration, awareness and agency. While people's motives for pursuing wealth differ, with differential consequences for WB, wealth and other materialistic values are often pursued as an anodyne for self-doubt and as a means for comparing oneself favorably against others (Landry et al., 2016). This is not integrative; rather, it is a defensive orientation inflamed by social evaluative threat, exaggerated by inequality (see Ch.5, section 11). This returns us to the critique of SWB (Ch. 2, section 4.1.2) as unable to distinguish between sources of high SWB that indicate health, and those that signify, for example, "the narcissist in prideful times" (Ryan and Huta, 2009, p. 203), whose fragile, defensive self-esteem is underwritten by shame (Tracy et al., 2011). Thus, the correlation between relative income and SWB may not track the actual phenomenon of WB, but may instead be an artifact of a naïve survey tool.

That being said, the more general question of status (beyond income) warrants further investigation (Anderson et al., 2015). As Sapolsky (2017, Ch. 12) notes, however, what matters for health and well-being seems not to be status per se, as what status means for how one is treated in a particular culture or group (and relatedly, how status cues are interpreted by the individual). That is, it's more fundamentally a question of social relations (and one's predictive model).

achievement is an outcome of an astounding confluence of connections beyond the individual human. From the microbes with which we are symbiotic (or those which can parasitize us), to the relationships that nurture and nourish us (or that misunderstand and traumatize us); from the non-human world that restores and soothes us (or that gets paved over and commodified), to the contagion of loneliness and the cultural modes that influence all of these domains—WB is a decidedly *collective* phenomenon. Cells in the body depend on the health and functioning of other cells for their own health and functioning, and further, on the health of the organism as a whole. Similarly, we as individual organisms depend on the health and functioning (i.e., WB) of other humans and of the broader planetary context of which we are part. Given the pervasive dynamics of interconnection and mutual influence, we cannot adequately understand WB if we view it as a solely individual matter. If we seek to achieve WB, an abstracted, atomistic view of the human will not only fail to reveal the available pathways and leverage points; it will actively misguide. This thesis's embedded, relational view of the human offers a more accurate and pragmatic map.

This is not to say that the individual level of analysis doesn't matter, but that it is best understood in relation to other individuals, and to other levels of analysis (e.g., neurobiological, cultural). The next section looks at the expression of WB at the individual human level. After that, in line with this section's multi-level, collective appreciation of WB, section 4 points to next steps in the development of a framework for understanding whole-systems well-being (WSWB).

## 3. Non-defensive functioning as central feature of human well-being

In this section, I introduce the idea of non-defensive functioning (NDF), which seems to be a fundamental human expression of WB. This thesis has demonstrated, through evolutionary, neurobiological, psychological, and social lines of investigation, that *defensive functioning* contributes to poorer integration, internally and externally, with concomitant decrements in self- and co-regulation, lower health and well-being, and compromised self-awareness and agency. In contrast, with a basis in non-defensive awareness, *non-defensive functioning* (NDF) refers to relating to our experience, sensations, emotions, friends, partners, etc., in a receptive, engaged, authentic manner, rather than with avoidance, reactivity, or control. Neurobiologically, it entails maintaining the mode of regulation governed by the PFC and parasympathetic nervous system (PNS). In this formulation, what is important is not simply NDF in the moment—i.e., not a sheltering from potential threats or challenges—but the growth in competence and agency that allows a greater capacity for NDF in a wider and wider variety of circumstances. Further, some of those circumstances will require active response when the stakes may be high. Thus, a noteworthy

class of NDF includes the capacity for *integrated arousal*, which may define resilience. NDF, then, —and WB—depends on expanding the range of optimal, integrated function; i.e., the "inverted U" (where function declines outside intermediate levels of arousal). This section addresses the development of NDF, its role in agency, integrated arousal as an expression of NDF, and resilience.

### 3.1. Developing non-defensive functioning

Importantly, NDF is a developmental achievement, requiring a safe context in which to grow one's capacities. Several closely related concepts pertain here. Between boring (unchallenging) and overwhelming (too challenging), both of which lead to disengagement, there is the realm of "optimal challenge", which facilitates the intrinsically motivated task-engagement of "flow" states in which mastery and competence are developed (Csikszentmihalyi, 1990). Similarly, in the "goldilocks effect" (Kidd et al., 2012), infants preferentially give attention to intermediately complex stimuli, as is theorized to best facilitate learning about the world (i.e., constructing a predictive model). In parent-infant interactions, an attuned parent maintains the level of stimulation within the "zone of proximal development": engaging but not overwhelming (Crittenden and Landini, 2015, *à la* child psychologist Vygotsky). In therapeutic settings, an attuned therapist stays within and expands the patient's "window of tolerance": the range of sensation for optimal integrative processing, without triggering dysregulation (Siegel, 2012). In optimal challenge, the goldilocks effect, the zone of proximal development, and the window of tolerance, we lean into the inverted U, as it were, expanding the range of integrated function. Our faculties are engaged and extended, rather than overwhelmed or left to languish, and we build resources for adaptively, non-defensively navigating life.

Another theory relevant to the process of widening the range of NDF comes from Barbara Fredrickson (2013). Whereas "negative" emotions tend to focus and limit attention and constrict cognition (e.g., as we've seen with threat), according to the broaden-and-build theory, positive emotions broaden attentional and cognitive range. This expanded awareness and thinking allows for more flexible and creative problem solving. These expansive states also support the expression of intrinsic motives for exploration and learning. Over time, these outcomes build resources for future adaptive responsiveness to circumstances. In addition, being in a good mood tends to facilitate intrinsic motivation for relatedness and to ease and enhance social interactions. Through these processes, the additional resource of social connection is built. Thus, positive emotions can lead to upward spirals of growth, competence, relatedness, and more positivity.

Given our exploration, we would expect this broaden-and-build effect to be mediated by the PFC-PNS connection. Indeed, Fredrickson's lab has found increased positive emotions to

produce increased vagal tone (Kok et al., 2013). In further resonance with our findings, the study found that change in vagal tone was mediated by an enhanced sense of social connection.

Worthy of note is that this study, and others from her lab, utilized training and practice in loving-kindness meditation to develop the capacity to self-generate positive emotions. This is not simple, passive "happiness", but attentional training in intentionally relating to oneself and others with love and kindness. That is, it is an integrative (healing) practice of developing self-regulatory capacity. So, the findings, though they are taken to show support for effects of subjective well-being (SWB) on health and social connection (e.g., Diener et al., 2017), are in fact more supportive of the organismic-eudaimonic view developed in this thesis.

### 3.2. Agency

It is worth emphasizing that without the agency that comes from successful development of integrated NDF, the affordances of choice and freedom that a context may provide are relatively meaningless. The reactivity of a poorly calibrated predictive model and its threat-sensitive psychophysiology is less free than the flexibly responsive, integrated agent. With defensive functioning, the creativity, proactivity, and flexibility of the PFC is overwhelmed, and the organism has only habit and reaction to rely on, driven by subcortical regions. Similarly, an internal working model that has cordoned off certain kinds and contents of awareness as off limits *is less free* than one that allows access to a wider range of its own emotions. To the degree that development of a model in which the self is effective and capable has not occurred, the world that that self inhabits will be filled with perceived threats. The next subsection notes a line of study pertinent to this idea.

### 3.3. Integrated arousal

As conceived here, NDF is not equivalent to low levels of sympathetic arousal: those with a high degree of integration are likely to experience stress as "eustress" rather than "distress" (Casad and Petzel, 2018)—i.e., as *integrated arousal*. In situations of motivated responding, eustress corresponds to the improved physiology and performance characteristic of the "challenge" profile[85], as opposed to the (distress) "threat" profile, which has poorer health and performance outcomes (Blascovich, 2008). The factor theorized to determine which profile is expressed is the implicit assessment of one's capacity to respond to the demands of a goal-relevant task.

As reviewed in Chapter 4 (section 2), defense can be categorized into two main types:

[85] In this research paradigm (the biopsychosocial model of challenge and threat), the challenge profile shows strong sympathetic cardiac activation, with quick response and recovery—even "vagal rebound", in which HRV increases beyond baseline in the recovery period. In contrast, the threat profile shows higher baseline sympathetic activity, greater vascular constriction, and slower recovery.

active and passive. Defensive functioning of either type is characterized by a narrowing of options and constricted range of attention; it is less flexible and more reactive. However, situations of motivated response need not be disintegrative. Impacts of the systems involved in defense (SNS, HPA, PNS) seem to be determined by the center of regulatory control: PFC, limbic system, or brainstem. At levels in the optimal range of the "inverted U", these systems function to enhance active response capacity and mental alertness to salient events and opportunities. If their activity is in coordination with (rather than in inhibition of) the PFC, then the system stays organized and adaptive (i.e., it doesn't "short-circuit").[86] Chapter 4 further provided evidence that the practice of mindful attention supports the PFC to stay online, supporting PNS activity in the face of the intense interoceptive sensations of arousal.

### 3.4. Resilience as the capacity for integrated arousal

Like Ryff & Singer (1998) criticize the tendency to define health as the absence of disease, Feldman (2020) also notes the general definition of resilience as the absence of negative outcomes after a potentially traumatic experience, rather than on what defines it in the positive. Trauma occurs when an event is so overwhelming as to trigger brainstem-level survival responses and shut down areas associated with higher-level functions (e.g., PFC, Broca's area, hippocampus; associated with executive functions and flexible response, language, and memory, respectively), overriding agency and leading to disconnect from body—with all the associated troubles stemming from that (see Ch. 4). The therapeutic process for healing trauma involves accessing and integrating the intense sensations that were intolerable in the moment, generally by first strengthening the capacity for embodied presence (with the help of a supportive, attuned therapist)—i.e., expanding the window of tolerance (Van der Kolk, 2015). Healing (integrating) requires the capacity to withstand intense sensation without "short-circuiting" into states of disintegration and dysregulation.

Key to the question of resilience is that not everyone responds the same way to a particular event. Some people go through "traumatic experiences" without suffering the breakdown of integration that characterizes trauma. Van der Kolk (2015, p. 82) notes that in an intense situation

[86] The role of oxytocin in maintaining integration (e.g., Feldman, 2020) deserves more attention in future development of the organismic-eudaimonic framework. With oxytocin, the collapse response may not always be dissociative. As I've briefly mentioned (see footnote 33), there is reason to be cautious in drawing from speculations in Porges's "polyvagal theory"; however, he poses the notion of "immobilization without fear" (the quality of trust and surrender in an intimate embrace) as the oxytocin-dependent, integrated action of collapse pathways. Though I cannot attest to the physiology involved, it seems plausible that in situations of deep trust and surrender, rather than of fear, some of the same pathways could be utilized (e.g., facilitating relaxation of muscle tone when in the arms of a lover as in the jaws of a jaguar).

like a plane crash, some people are so overwhelmed that they lose consciousness; others panic; but some "keep it together" (i.e., stay integrated) and are able to respond effectively, e.g., by helping others escape. Members of the third group rarely suffer from PTSD. What determines whether we pass out, freak out, or help out? If "Dissociation is the essence of trauma" (Van der Kolk, 2015, p. 66), then the capacity to remain integrated with high levels of arousal (and the attendant intensity of interoceptive-emotional experience) should not only allow one to respond more flexibly in the face of danger, but will likely be protective against post-traumatic dysfunction.

Because emotion is fundamentally interoceptive, the capacity to stay present in intense interoceptive sensation—having a wide inverted U—also applies to emotional experience. If emotions are to be non-defensively engaged and integrated, rather than controlled through repression, suppression, distraction, or reappraisal (Roth et al., 2019), this too requires the capacity to withstand intensity. In turn, this supports a greater social functionality, initiating various upward spirals of wellness. Thus, for human beings, non-defensive functioning is both an expression of, and means to, integration and WB. The next section moves beyond the focus on the individual human, to consider well-being at other levels in the emergent hierarchy of system organization.

## 4. Towards a framework for understanding Whole-Systems Well-Being

This thesis's organismic-eudaimonic approach sets us up well to address WB beyond the level of the individual human. This is in part because a certain scale-independence of patterns is inherent in the study of systems: similar dynamics show up at various levels of the emergent hierarchy. If integration and self-organization are properties of flexible, adaptive systems in general, this suggests that differentiated linkage may underlie health and WB at whatever level of system organization. Further, a focus on function is what distinguishes a *eudaimonic* from a *hedonic* approach, the latter being solely concerned with subjective experience. Medically, for instance, such a focus is already the norm as regards lower levels of system organization. For example, we may speak of a diseased liver: the hedonic approach makes no sense here (what can we say of the experience of the liver?), but clearly the organ's function has declined. This decrease in function has consequences horizontally to other organs as well as vertically to the organism as a whole. But what about WB at higher levels of order and emergence? Taking a more comprehensive and functional view of WB (rather than a purely subjective and experiential one), the organismic-eudaimonic approach offers a coherent framework for considering WB on levels other than just the individual: *whole-systems* well-being (WSWB). The following subsections indicate that this is a promising direction for future research.

### 4.1. Groups

In this thesis, we have already discussed integration at the relational level. Applying the notion of differentiation and linkage to relationships, we can consider integrated relationships not only as health-promoting, but perhaps as healthy in their own right. Beyond dyadic systems, there is the possibility of group or community integration. For instance, Baumeister et al. (2016) find that group function is enhanced when there is acceptance and functional differentiation. These are precisely the elements that lead to the emergence of a self-organized whole.

### 4.2. Social-ecological systems

Another body of work expands the view of community-level self-organization to social-ecological systems, focusing on the local regulation of common-pool resources. Elinor Ostrom (2010) has shown that very often, distant bureaucratic and control-oriented approaches are not functional, but that local community regulation, in supportive conditions, can be effective at maintaining their resource base. Part of what is required for groups to function well is having the autonomy to monitor the system and make their own rules: i.e., to *self-sense* and *self-regulate*. From this assessment, it seems that the "tragedy of the commons" only occurs in a context of dis-integration. (Thus mainstream economic assumptions—e.g., that humans act as atomized self-interested "utility maximizers"—describe not the ultimate truth of human beings but a special case of human behavior in circumstances of disconnection and disrupted communication (Ostrom, 2010).)

Further, based on the preceding chapters, we can also expect the community affiliation, nature contact, and other aspects associated with local regulation to have additive benefits to the people themselves. Indeed, as suggested in the previous chapter, attuned responsiveness to ecological process, inherent in practices like permaculture and commons management, for example, and the intimate relationships forged through local harvesting, etc., are likely elements of a fuller connection with the non-human world (i.e., beyond simple exposure). In support of this hypothesis, a study on the benefits of ecological restoration projects to volunteers found significant positive impacts on measures of life satisfaction and life functioning (Miles et al. 1998). Again, we find not only correlation, but mutuality between the WB of different aspects of the system.

### 4.3. Governance

Integration requires a balance of top-down and bottom-up. For example, in the body, if predictions dominate the up-flowing sensory information, dysfunction results. However, if top-down regulation is unable to coordinate effective action, dysfunctional states also result. That is, integration requires mutual responsiveness. In governance, this is also evident: when higher levels of organization are not sensitive and responsive to the people on the ground, this results in a

dysfunctional state. Similar to Ostrom, eudaimonic economist-philosophers Sen (1999) and Max-Neef (1991) both emphasize bottom-up self-organization. Yet, as in the body, there is also an important role for high-level organization and coordination. Daly & Cobb's (1994) notion of subsidiarity poses that regulation should be carried out at the lowest level possible—which, in some circumstances, is at the global level.

### 4.4. Ecological/Planetary

At the ecological level, it is common to speak of ecosystem function as a measure of ecosystem health (e.g., Naeem, 2006; Wright et al., 2009). These functions are the result of many interactions and linkages, characteristic of integrated, self-organized processes. Even the earth as a whole, via this definition, could be seen as in declining WB due to a breakdown of complex linkages and its tipping toward a threshold into a highly resilient but inhospitable mode of planetary regulation: a climate regime termed "hothouse earth" (Steffen et al., 2018). Indeed, there is growing recognition of planetary-scale function (Jabr, 2019), crucial for the function and integrity of many levels of organization nested within it, like ecosystems and societies.

### 4.5. Economic

What would we say of the present societal mode? It is self-regulating, resiliently self-perpetuating, and self-propagating, but in a mode that is out of integrity with the larger whole and its constituents alike (Coffman and Mikulecky, 2015; Gowdy and Krall, 2013). In contrast to the mutual, collective nature of WB highlighted by this thesis, neoclassical economics' (NCE) assumptions pit us against each other and the planet of which we are part. From the perspective of the organismic-eudaimonic framework, such assumptions are akin to posing that the body functions best when organs compete for resources. The hierarchical nature of systems, according to which one can zoom in or out and see similar patterns independent of scale, suggests the connection with the dynamics of a malignant tumor: We are like cells in the body of the planet, but under the operating system of NCE, we've become cancerous.

#### 4.5.1. Economic growth as planet cancer

Cancer has several defining characteristics (Cooper, 2000) common also to NCE's emphasis on consumption and economic growth: Growth beyond normal boundaries, the centralized consumption of resources, the invasion of neighboring cells and tissues to get those resources (see the Global South and the natural world in general), and metastasis: spread to other tissues (see the "developing" world). Another element of cancer is that in the process of mutation that leads a cell to become cancerous, its communication with other cells becomes dysregulated (Cooper, 2000), perhaps analogous to the conditions leading to the tragedy of the commons mentioned above.

Essentially, like society acting according to the fundamental ontological dichotomy between humans and nature, cancer acts like it's a separate organism—but it is not. Both cancer and the present societal mode are self-regulating systems out of integrity with their larger whole; unchecked, they undermine the basis of their own existence.

### 4.6. Developing integration: towards achieving WSWB

A degraded ecosystem may need intelligent intervention to shift into an alternative stable state and come into restored function (Whisenant, 1999). An individual can be unwell and require some kind of intervention to restore health, whether through modern medicine, or through psychotherapy. A relationship may need mediation to help its members come into healthy connection. What of "collective pathologies" (Max-Neef, 1991)? Many societies have become increasingly atomized and polarized (for the US case, see Putnam, 2000; McPherson et al., 2006; Andris et al., 2015). We largely lack the skills of dialogue that would allow us to come to mutual understanding and shared intentionality (Tannen, 2012). What, then, is the process of restoring function to communities? How can a community develop its capacity to come into integrity within itself and with its ecological milieu? How might a global economic regime be transformed?

These are important issues to address in working toward whole-systems WB (WSWB). There is much that we could prioritize and value as a society: the work of healing, of learning, of regenerative agroecology, of facilitating rich community, of ecological restoration, etc. Working at every level of WB, and in a variety of ways, we have the potential to invest our time, attention, and resources to set in motion the upward spirals of integrative system dynamics. Such synergies will be a primary focus in the development and implementation of a political philosophy of WSWB. Increasingly, however, epistemological issues seem to be a primary hurdle in working toward WSWB. That is, the lack of a consensual reality or a means of arriving at one stymies the necessary discussions before they even begin (McIntyre, 2018). The next section, through reflecting on the research process of this thesis, further extends the thesis's framework to comment on this epistemological quandary.

## 5. Reflections on the process: Critical Interpretive Synthesis and Predictive Processing

I here reflect on the parallels between critical interpretive synthesis (CIS, see Ch. 3), complex systems (see Ch. 1, section 5; Ch. 2, section 7), and predictive processing (PP, see Ch. 4). A quote from Wendy Wheeler is particularly apt in describing my own process:

> According to the procedures of our particular discipline, we write proposals; but we know these won't really describe the *actual* processes of our encounter with rationality – because

> this will derive from tacit skills that we can't 'propose' in conventional linguistic form. Then we read books, or while away our time with other relevant pursuits such as programmes of laboratory or field research, but what we are *actually* doing, no matter how well we try to disguise this fact from ourselves, is *having faith* in the rationality of the problem we have discerned, and *waiting* for a way forward to present itself to us. [...] the move to the next stratum, if it comes, arrives in a relatively mysterious way […W]e follow leads which are essentially hunch-like. The more we give ourselves over to an apparent serendipity, the closer (paradoxically according to modern theories of knowledge) we come to real discovery. There is, thus, an apparent (and real) randomness to research and creativity, but, as [Michael] Polanyi argues, randomness is a feature of emergence. We simply *don't know* all the complex particulars via which new strata emerge. (Wheeler, 2006, pp. 89–90, emphasis original)

These "eureka" moments of synthetic, explanatory theorizing seem to be yet another example of the complex systems principle of self-organization. The process of wondering how seemingly related phenomena are related involves the creation of networks of ideas characterized by dynamic, mutual influence, allowing the ideas to shift in their relationships to each other until they emerge as a larger whole that is robust in the context of the available data. This continual process of conceptual evolution, guided and constrained by "epistemological selection", carries on across the hierarchical levels of synthesis, so that these wholes in turn arrange themselves into larger wholes.

According to the *predictive processing* model, which became a theme and frame for much of the body of this thesis, this process of sense-making is a deep functional feature of the brain and of living systems more generally (Friston, 2012; Ramstead et al., 2018). That is, these dynamics are apparently quite fundamental; perhaps it is significant that this research found its methodology to be an expression of the pattern it was studying.

The cross-domain parallel extends even further. CIS directs the researcher to pay special attention to contradiction, i.e., rather than simply cherry-picking the evidence that supports the hypothesis and ignoring or negating evidence that seems not to. In attending to the data that doesn't accord with expectations, the model is able to update. This is the bottom-up strategy of prediction-error minimization (what we have called perceptual inference), versus the active inference strategy of bringing data into alignment with the model, or the ignoring or discrediting of conflicting data. All too often, though, these latter strategies are employed to maintain a cognitive/conceptual structure, like a belief system or ideology. With such dogmatic loyalty to belief, rather than to

evidence, reasoning is employed (or withheld) in a motivationally biased manner. This is an expression of ideologically motivated processing (IMP).

## 6. Ideologically Motivated Processing

Throughout human evolution, loss of belonging has been a legitimate threat to survival, with pervasive impacts on the human organism (see Ch. 5). In keeping with this understanding, the motive to preserve an ideology may be seen, at least in part, as a motive to preserve membership in one's group(s) (Adams, 2018; Haidt, 2012; Kahan, 2017). Such "identity-protective" motives "distort all manner of information processing—from logical inferences to assessments of expertise; from recollection of events to brute sense impressions" (Kahan, 2017, p. 26)—much like the perceptual, attentional, and memory biases of insecure attachment. In the case of attachment insecurity, it is originally the *threat to the connection* that makes particular experiential contents (distress, anger, etc.) off limits. Similarly, in a circumstance in which ideology is a prerequisite for group acceptance, i.e., in which heresy may lead to excommunication, this threat is motive enough to obscure boat-rocking meanings that might emerge if dots were allowed to connect. Thus, in ideologically motivated processing (IMP), certain perceptions and conclusions are defensively excluded from consciousness so as to maintain relationships.

The kind of relatedness that depends on toeing the line is, of course, not what we have described as optimally connective. Contexts that support freedom of thought and expression are those in which relationships are secure, in which there is a foundation of safety (Adams, 2018). This, again, fits into the various perspectives synthesized in the organismic-eudaimonic framework. I have just described the dynamic from a psychosocial perspective, but we can also affirm it from the neurobiological: social safety supports the vagus, which further supports the intrinsic motives of exploration and curiosity, together with the broadened thinking and attention of the engaged PFC. Alternatively, threat-oriented processing restricts awareness and shifts the center of regulation away from the PFC to modes of self-preservation.

A prime example of IMP is the denial of climate change. In PP, whereas perception is generally constrained by actual sensory information and the propagation of prediction error up the sensory hierarchy, hallucination can be considered unconstrained perception (Clark, 2015, p. 196). Similarly, motivated reasoning has been conceived of as constrained by one's "ability to construct seemingly reasonable justifications" (Kunda, 1990, p. 480). It is by now well established, however, that in the case of climate change there has been a well-funded, concerted, and quite successful effort to *unconstrain* reasoning (and information processing more generally) by deliberately

sowing doubt and "seemingly reasonable justifications" into the public discussion (Brulle, 2014; Oreskes and Conway, 2011). In PP terms, confidence in the data is turned down so that the prior belief is not updated. In addition, through politicizing the matter into a "wedge" issue, these "merchants of doubt" (Oreskes and Conway, 2011) harness people's loyalties to their ideological "tribes", further enlisting defensive motives. Widespread lack of connection (McPherson et al., 2006; Putnam, 2000) and growing polarization (Andris et al., 2015) seem to be part of what makes a society vulnerable to such manipulations (Adams, 2018). Importantly, the effort to sow doubt and discord is, in turn, a further example of the self-regulatory resilience of the societal operating system we have just likened to cancer of the planet (Coffman and Mikulecky, 2015)—i.e., confidence in the data is turned down so the *societal* regulatory model is not updated.

Other motives are likely in play as well. Confronting the reality of the current socio-planetary trajectory without resorting to passive or active defenses (e.g., dissociation, denial, justification) requires a highly developed capacity to be present in intensity—i.e., for integrated arousal. (This is often called courage; here it is emphasized as a developmental achievement with a significant dependence on environmental supports.)

In working toward WSWB, IMP is perhaps the biggest obstacle to successful collective action and social transformation. The present framework, with the expansions suggested in this chapter, stands to elucidate the complex inter-domain and multi-level dynamics of WSWB: relational safety and emotional integration support honesty and cognitive clarity; strength of the neural connections in the central autonomic network supports responding adaptively to potentially terror-inducing circumstances without collapsing or reactively defending the status quo (Martens et al., 2008; Hennes et al., 2012); and these capacities seem necessary for the capacity to consciously, collaboratively alter the societal mode that is wreaking havoc on planetary-scale WB.

## 7. Further transdisciplinary convergence

A particularly rich avenue for future research is to connect with contemplative wisdom traditions, and indigenous perspectives and practices like buen vivir (Acosta, 2015). Indeed, the common insights at many religions' mystical core (collectively referred to as the perennial philosophy; Huxley, 1946) have many connections to the view presented here. Wisdom traditions commonly note that in some sense we are asleep, in delusional self-protective modes of being, and that there is the possibility of waking up, of giving up the sense of the self as separate, to experience the differentiated linkage of oneself with the cosmos. These views speak, in various ways, of being deeply present (aware), letting go of mental constructs and control (Hagen, 2009), surrendering in

faith to what is beyond concept, and letting a deeper harmony and unity self-organize.[87] Choosing to relate to oneself, others, and wider systems with an approach of receptive connection as opposed to one of "command and control" (Holling and Meffe, 1996) seems to require a trust in the self-organizing principle that pervades all of these systems and guides organismic development (Landry et al., 2008)—that is, faith in Life itself.[88,89]

This thesis also converges strongly with the common indigenous recognition of relationality and unity[90], as in the North American idea of "all my relations" (King, 1990), and the African "ubuntu", often translated as "I am because we are" (Mugumbate and Nyanguru, 2013).

That is, this research suggests that the conclusions of an integrated Western/scientific perspective may in fact resonate with those of indigenous and wisdom traditions across the world.

## 8. Limitations

Transdisciplinary synthesis is ambitious. In order to fit within the page and time lengths afforded to a master's thesis and at the same time span the multiple disciplines of this project, I could not always "show my work". That is, in arenas where various views exist in the literature, I could not justify all of my syntheses by including an in-depth analysis and critique of each view and an explanation of how coherence emerges. That being said, I believe the coherence I have demonstrated is compelling, and that the basic structure is sound. I hope that this thesis stimulates the finer-grain conversations to further explicate and hone the framework I've presented.

In addition, there is much potential for the framework to be extended, as the above sections note. Along with what was mentioned above, future work could connect with other burgeoning visions of the sustainable good life, like degrowth (Büchs and Koch, 2019; Kallis et al., 2018). It should also integrate the literature on nature connection and more rigorously investigate and synthesize the various schools of thought around complex systems.

Further, being more primarily about the human *situation*, this work has treated human *motivation* only secondarily in this work; a more direct treatment is necessary for a fuller foundation for political philosophy. Neoclassical economics' telling is woefully incomplete at best,

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[87] "If you are seeking, you must not stop until you find. When you find, however, you will become troubled. Your confusion will give way to wonder. In wonder you will reign over all things, and your sovereignty will be your rest." Logion 2, Gospel of Thomas (Bauman, 2014)

[88] or "God", if you like (Kauffman, 2008).

[89] In emphasizing flexibility as an expression of system integrity and health (Kashdan and Rottenberg, 2010), our framework resonates particularly well with Taoism: "Men are born soft and supple; dead they are stiff and hard. Plants are born tender and pliant; dead, they are brittle and dry. Thus whoever is stiff and inflexible is a disciple of death. Whoever is soft and yielding is a disciple of life. The hard and stiff will be broken. The soft and supple will prevail." (Laozi, 1988, v.76)

[90] As is also recognized in wisdom traditions: e.g., a central phrase in Sufism is Wahdat al-Wujud, "Unity of Being".

but ecological economics (EE) has not found an adequately comprehensive, nuanced, and empirically and theoretically sound replacement. I posit that self-determination theory (SDT) offers this rigorous, scientific basis, and I hope to bridge from it to EE in future translational work.

## 9. Summary

This thesis suggests that human WB is expressed in non-defensive functioning, and that the most important factors for its development, beyond material sufficiency, are attentional, collective, and mutualistic, as opposed to consumptive, individual, and rival. The more fundamental process associated with WB—i.e., in the individual human and beyond—is that of integration: the linkage of differentiated parts of a system.

As should perhaps be expected with a work attempting to construct key elements of a worldview, there are many potential implications and hypotheses spurred for future investigation. This work therefore doubles as something of a research agenda, prompting many unanswered but interesting and important questions.

# Chapter 8 – Conclusion

In this final chapter, I recapitulate the justification and findings of the thesis as a whole. I reiterate the objectives of the research and affirm that they were met, pointing also to implications of the thesis's findings.

I began this thesis noting that the societal mode that has led to the crises of the Anthropocene is based in outdated worldviews, characterized by a fundamental dichotomy between humans and nature. I further noted that efforts toward radical transformation (increasingly recognized as necessary to avert disaster) suffer from a lack of a suitable conceptual foundation. Specifically, I identified a need for an embedded understanding of the human and a consilient theory of well-being (WB). Accordingly, this thesis focused on the intersection of these two fundamental gaps by investigating the relevance of human embeddedness—as *embodiment, sociality, and terrestriality*—for human WB.

Investigating prominent conceptions of WB, I found a need for an account of WB that is consistent with the corpus of knowledge on human [neuropsychological] development, neurobiology, evolution, and clinical psychology. Aiming for a coherent understanding of WB, I set out to articulate a framework that would respond to these gaps, as well. I called this framework *organismic-eudaimonic* to emphasize the orientation to function, grounded in the neurobiological organism as a complex system. Because in this frame, WB is understood to be determined by self-regulatory dynamics, the investigation aimed to reveal how the three focal relationships (to the body, other humans, and the rest of nature) impact regulation, and in turn, health and WB.

I found the impacts to be profound and deeply interrelated. Specifically, I demonstrated that the *quality of the relationships* to the body, to other humans, and to the more-than-human world each play key roles in the various levels of function (neurobiological, psychological, social, and likely even ecological) that constitute WB. My findings strongly support the premise that integration, defined as the linkage of differentiated parts of a system, underlies the flexible, resilient regulation characteristic of WB. Integration was found to yield greater agency and ability to accomplish one's goals, a more coherent sense of self, less mental illness, healthier physiological profiles (better autonomic, endocrine, and immune regulation), relationships that are more genuine and satisfying, and more positive emotional experience (but also acceptance, awareness, and integration—and thus more successful regulation—of the whole range of emotions). I found defensive functioning (at the interrelated levels of physiology, psychology, and sociality) to be associated with less integration (neurologically, psychologically, and socially), and thus with lower WB. In contrast, a robust capacity for integrated, non-defensive functioning

appears to be the essence of WB as expressed in the human being.

By incorporating evolutionary, developmental, neurobiological, and clinical understandings of the human and its function and wellness, the organismic-eudaimonic conception of WB thus coherently subsumes the bases of many other conceptions of WB (i.e., within both hedonic and eudaimonic schools of thought).

The organismic-eudaimonic view developed in this thesis provides a frame for understanding human being and well-being. Indeed, the dynamics outlined seem to be so fundamental that they describe WB at any level of analysis. These ideas are key elements of a foundation for a political philosophy for whole-systems well-being. Further, this thesis suggests that, beyond material sufficiency (adequate food, shelter, etc.), the most important factors for WB are attentional, rather than consumptive; mutualistic, rather than rival; and collective, rather than solely individual. This has profound implications for the prospects for mutually beneficial human-earth relations. It provides a societal goal that frames human WB not as antagonistic to the WB of other humans or the planet, but as interdependent, with many opportunities for positive synergies. Future research is needed to elaborate and specify the ways in which such synergies can be tapped in societal organization.

In this thesis, I have synthesized a wide variety of theories, data, and lines of research to propose a consilient framework for considering the human and its WB. In doing so, I reconciled physiological, objective, scientific perspectives with experiential, subjective, and relational realms. The framework therefore does not rest on dichotomies between human and nature, mind and body, or reductionism and relativism, but moves beyond atomistic/dualistic views to one in which dynamic relationality is central and pervasive. I have demonstrated the relevance of the body, others, and the rest of nature to the regulatory dynamics underlying human health and well-being. In addition, I have shown that these facets of the human situation are fundamental not just to our well-being, but to our very being itself. By accounting for these dynamic interrelations, this meta-theoretically coherent scientific synthesis offers a key part of a foundation for creating a political philosophy of whole-systems health and well-being. This thesis therefore contributes to the effort to transition from the Anthropocene to the Ecozoic (Berry, 1999); i.e., to an era of mutual flourishing in human-earth relations. There is much work still to be done toward the required societal transformation. I hope that this work serves to bring us closer as a collective to responding adaptively to the challenges facing us.

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