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THE HUMAN DEFAULT CONSCIOUSNESS, JHĀNA CONSCIOUSNESS, GAIA “CONSCIOUSNESS” AND SOME THOUGHTS ON THE COVID-19 PANDEMIC

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ABSTRACT

In a recent paper (Dennison, 2019) the term “human default consciousness” (DCs) was coined to describe the everyday consciousness that we live within throughout most of our lives. The default nature of that consciousness was highlighted by its profound disruption during a little-known yet core practice within Buddhist meditation traditions, jhāna meditation, which explicitly requires meditators to withdraw or disengage, temporarily, from engagement with the sensory world. The default consciousness is therefore a sensorily-based consciousness. The profound effects on brain activity that were observed to result from this withdrawal highlighted just how powerfully embedded the default consciousness is, and what a significant undertaking it is to disengage the personal element.

In this chapter we explore in more detail the characteristics of the DCs as it has featured in philosophic thought, in psychoanalysis and mental health, as well as in Buddhist thought and from a modern neuroscience perspective. We then compare and contrast the form of consciousness that emerges in jhāna meditation, before extending the discussion to recent neuroscience models of nested hierarchies within self-organising systems and their associated Markov blankets, with implications for the forms of consciousness that may or may not arise in those systems.

We also discuss briefly the outermost hierarchical system, that of planet Earth in interaction with worldwide societies, and the likely information geometries linking “outer” with “inner”. In light of the current crises of climate change and the Covid-19 pandemic, we speculate on the possibility of breakdown of this outermost Markov blanket system.

INTRODUCTION

Our starting point is the notion that we live within a *default* sensory consciousness (DCs), and that it is this default consciousness that has been the subject of the majority of views and researches on consciousness across more than two millennia, across many diverse fields. Perhaps because of the very diversity of those fields, it is easy to lose sight of the common motivation to understand the *subjective* experiences of individuals living in the world, and of their being conscious that they are conscious. Each of these fields, in different ways, has sometimes verged towards the abstract, but when they focus more directly on the relational and intersubjective nature of consciousness they share much common ground, and important themes emerge.

Within neuroscience, this shift from the abstract has accelerated over the last 10 years, prior to which the majority of neuroscience studies attempted to identify the so-called neural correlates of consciousness (NCC); that is, which networks become activated or de-activated when subjects are given tasks: visual tasks, auditory tasks, memory-based tasks, tasks that test action-choice, emotional

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reactions, and many others. However, the sheer complexity and inter-relatedness of the brain's networks leads to as much ambiguity as clarity of understanding in many of these studies. In 2010 this all changed, with Friston's (2010) Free-Energy Theory which treated the brain as a self-organising biological system following Bayesian dynamics, and a veritable avalanche of studies followed. The focus currently is around models of adaptive active inference where the brain and the "organism" engage with the outer sensory world in such a way as to minimise "surprise" or excessive disturbance in action choices. The "who" or "what" that determines the choices of action is only now attracting the attention it deserves, taking the adaptive active inference and free-energy-minimisation models closer to convergence with other disciplines in exploring consciousness as a relational phenomenon.

The common ground is that of individuals living within a sensory world, which is the reason that this chapter explicitly names the subjective experience as the human default *sensory* consciousness (DCs).

In Section 1, we explore the characteristics of the DCs by identifying common themes from the above-named different disciplines. This is followed in Section 2 by a radically different approach, based on the EEG study of Buddhist *jhāna* meditation described in Dennison (2019). This little understood but ancient form of meditation specifically requires practitioners to (temporarily) disengage from their default sensory consciousness; the rationale being to facilitate insight into the habitual processes of "I am" and "I do" which are regarded in Buddhism as root causes of attachment and craving leading to mental suffering.

This EEG study arose from simple curiosity as to what changes in brain activity, if any, might underpin the intriguing subjective experiences of practitioners of this mode of meditation, which to date had not been researched in any depth. What was not expected, were the remarkable and profound disruptions to brain activity observed as meditators with a range of expertise progressively strove to disengage from their DCs. Not only were the effects observed quite different to any previous EEG studies of a wide range of meditation modalities, the disruptions were, in some cases, so profound as to raise great scepticism in initial responses to the study.

After extensive analysis, however, it became clear that the nature of the disruptions to brain activity confirmed much of the ancient Buddhist understandings of *jhāna* as a method specifically aimed towards disengaging from sensory consciousness into what has long been understood within those old meditation traditions as an alternative form of consciousness known as *jhāna* consciousness, experienced as embodied "presence" temporarily free from the familiar subjective components of "I am" and "I do". It also became clear, again unexpectedly, that the disruptions were entirely consistent with recent developments in neuroscience that model brain activity under the general headings of the free-energy principle and adaptive active inference.

Having described these two modes of consciousness – the DCs, and *jhāna* consciousness – the discussion moves on in Section 3 to consider broader implications informed by models of nested Markov blankets at hierarchical levels of self-organising systems, to explore what "consciousness" might mean at these different hierarchical levels. In Section 4 we explore the outermost such system, that of the planet itself in relation to societies and individuals worldwide, and revisit the idea of a "Gaia consciousness". In that vein we explore the possibility that the Covid-19 catastrophe at the societal level, and dramatic and disruptive climate change at the planetary level, may evidence breakdown of the Markov blanket defining this outer system, with implications for how such a breakdown might be addressed, and avoided in the future. The final section attempts a brief summary/conclusion.

1. THE HUMAN DEFAULT CONSCIOUSNESS IN WESTERN PHILOSOPHY, PSYCHOANALYSIS, BUDDHISM AND NEUROSCIENCE

WESTERN PHILOSOPHY

Whilst acknowledging that Western philosophers were heavily influenced by early Greek philosophers, in particular Plato and Aristotle, we choose to focus instead on the Western philosophical currents from the 17th up to the late 18th century, that strongly influenced Freud and others from the late 19th century through the 20th century to the present day, in their attempts to understand consciousness and perception. We take Leibniz (1646–1716) as a key figure, since his insights are especially relevant to modern neuroscience, and the relational nature of what we are focusing on – our default everyday consciousness.

Leibniz was a mathematician (he discovered infinitesimal calculus independently of Newton), and the precision of that discipline is evident in his views on consciousness in his *New Essays Concerning Human Understanding* (Leibniz, 1707), written as a commentary and reply to the English philosopher John Locke's *An Essay Concerning Human Understanding* (Locke, 1690). Leibniz's work was almost certainly well-known to Freud, having been available in a German edition through Gerhardt (1875–90), and his writings are a rather beautiful example of that capacity of human beings to reflect on their own subjective experience of being conscious. Extracts below from Langley's (1896) translation of Leibniz's *New Essays* are marked L1, L2 and so on for purposes of reference later in this chapter¹.

Perception and Consciousness

In what can be considered an exploration of the thought process, Leibniz examines the effect on a person (Leibniz's *monad*) of "impressions", or "external things", which implicitly in his writings refers to sense impressions from without (or, sensations from the body, L8 and L9 below). Perception is described as the internal registration of an external object or event, and he coined the term apperception (*s'appercevoir*), a concept new to the field of psychology at the time, to be the defining characteristic of consciousness as a process of reflection on the perception:

L1 "It is well to make a distinction between the *perception*, which is the internal condition of the monad representing external things, and *apperception*, which is *consciousness* or the reflective knowledge of this internal state" (Leibniz [1707], 1896, p. 136, n.1, Leibniz's emphasis).

L2 "there are at every moment an infinite number of *perceptions* in us, but without apperception and reflection, *i.e.* changes in the soul itself of which we are not conscious, because the impressions are either too slight and too great in number, or too even, so that they have nothing sufficiently distinguishing them from each other" (*ibid.*, p. 47, Leibniz's emphasis).

Statement L2 is in stark contrast to Locke's (1690) Cartesian view of the mind as transparent to its contents, that there could not be anything in it of which it was not conscious. In other words, Leibniz recognised the need for unconscious as well as conscious mental contents.

The Strength of Impressions, Differences Between Them, and Their Meaning to the Recipient

¹ The Langley translation has been criticised in comparison to the more recent Remnant and Bennett (1982) translation, but is preferred here as, in some cases, capturing more of the subtlety of Leibniz' original text. For example, apperception (French *s'appercevoir* in Leibniz) is not referred to in Remnant and Bennett, and is replaced by "being aware" which misses the important role of *reflection* on a perception as leading to consciousness.

Statement L2 describes that whether or not impressions and perceptions become conscious is determined by their strength, whether one becomes distinguishable from another, or whether on the contrary they are *too even*. This role of comparison or discrimination between impressions is equally recognised as important in Buddhist models of the thought process, and in neuroscience models of the processes of predictive inference.

Leibniz goes further in naming the importance of what impressions *mean* to the recipient, thereby introducing feeling:

L3 “*What moves the mind on each particular occasion ... to remain in the same state or continue the same action, is solely the present satisfaction we find therein. On the other hand, the motive which incites to change is always some uneasiness (ibid., p.188, Leibniz’s emphasis).*”

L4 “*... these continual little successes ... or lessening the feeling of pain, is already a considerable pleasure. I find uneasiness is essential to the happiness of created beings which [happiness] never consists in complete possession” (ibid., p. 194).*

Statements L3 and L4 are far-reaching insights, which presage Freud’s Pleasure Principle, first mentioned in his *The Interpretation of Dreams* (1900) and later in *Beyond the Pleasure Principle* (1920). The suggested interplay between liking and disliking, pleasure and pain, are also entirely consistent with Buddhist views of craving and attachment as the roots of mental suffering (Harvey, 2012), as well as playing key roles in action-choice in predictive active inference (see section on neuroscience below).

Attention

The role of attention is implicit at various points in Leibniz’s *Essays*; in L5 below as a necessary part of consciousness; in L6 as “attend to”; and in L7 which implies a choice, whether conscious or unconscious, as to what is attended to at any particular moment:

L5 “The apperception [consciousness] of that which is in us depends upon attention and order” (*ibid.*, p. 76).

L6 “We must consider that we think of many things at a time, but we attend only to the thoughts which are most distinct, and the process cannot go on otherwise” (*ibid.*, p.113).

L7 “It is very necessary that I cease reflecting upon all these reflections, and that there should be at length some thought which is allowed to pass without thinking of it; otherwise, we should dwell always upon the same thing” (*ibid.*, p. 119).

The dependence of consciousness on attention above corresponds well to the EEG study of jhāna meditation to be described later, which demonstrates attention to be the primary anchor of sensory consciousness, and that the brain’s attention networks are the first to be disrupted when practitioners of jhāna meditation begin to disengage from their default consciousness. This central role of attention is also recognised in neuroscience models of active inference as mediating between “inputs” from the outer sensory world, and internal processing leading to action choice. The insight of L7 is also highly relevant in the same neuroscience context as being required to allow “updating” of predictions regarding future actions and outcomes (see section on neuroscience below).

Leibniz also recognised the importance of bodily sensations, including those which are unconscious (interoception), in addition to sense impressions from the external world, in determining feelings and action choices:

L8 “All impressions have their effect, but all the effects are not always perceptible; when I turn to one side rather than to the other, it is very often through a series of minute impressions of which I am not conscious, and which render one movement a little more uncomfortable than the other” (*ibid.*, p. 116).

L9 “...it is these minute perceptions which *determine* us in many junctures without being thought of, and which deceive the vulgar by the appearance of an *indifference of equilibrium*, as if we were entirely indifferent whether we turned to the right or to the left ... I notice here... that they cause that uneasiness which I show to consist in something which differs from pain only as the small from the great, and which, however, often constitutes our desire and even our pleasure by giving it an exciting flavour” (*ibid.*, p. 49, Leibniz’s emphasis).

Order, in Time and Space

Statement L5 above refers to attention being an essential component of consciousness, but also names *order* as being equally important; and since statements L6 and L7 refer to the thought process as something that *goes on*, and that attention has to let go of one impression to move on to the next, it is clear that Leibniz is speaking of an ordering in time. Elsewhere Leibniz refers to order in the context of his view that arithmetic and geometry are innate to human beings, and that order is interrelated to an ordering in space as well as time.

L10 “In this sense it must be said that all arithmetic and all geometry are innate, and are in us virtually, so that we can find them there if we consider attentively and set in order what we already have in the mind,” (*ibid.*, p. 78).

L 11 “Space is the order of co-existing, as time [is] of successive phenomena” (*ibid.*, p. 128).

These insights regarding order have relevance to the two attention networks disrupted as meditators disengage from sensory consciousness, one closely related to position in time, the other in space (see EEG study below); and also to the way neuroscience models of active inference are required to predict forwards to varying extents, based on prior experiences (see neuroscience section below).

Language

As a mathematician, Leibniz had a great interest in the use of symbols to represent ideas, but even from a very early age he had speculated on a primal language of thought as a boy, when “I came upon this remarkable consideration, namely, that a certain *Alphabet of human thoughts* could be invented, and that from the combination of the letters of this alphabet, and from the analysis of the words formed of them, everything could be both discovered and tested” (quoted in Russell, 1900, p. 283). Although Leibniz did not develop those ideas fully, it is clear in the *Essays* that he regarded language as an integral feature of the interrelationships that together make up the human experience of being conscious; in other words, that language underpins cognition:

L 12 “I truly think that languages are the best mirrors of the human mind, and that an exact analysis of the signification of words would show us better than anything else the workings of the understanding” (*ibid.*, p. 368).

We will see counterparts to this in the sections on psychoanalysis and Buddhism that follow.

Finally, a rather enigmatic statement (L13) where Leibniz comments that reflection (L1, apperception) is not limited to consciousness of impressions or ideas, but “reaches to the mind itself”,

reminiscent of an age-old question in Buddhist psychology as to whether the mind can be aware of itself (see section on Buddhism below).

L 13 “...reflection is not limited to the operations alone of the mind... it reaches even to the mind itself, and it is in the consciousness of self that we perceive substance” (*ibid.*, pp. 23–4).

PSYCHOANALYSIS

Given the above, Freud, as the father of psychoanalysis, was clearly not the first to consider unconscious mental processes by the time he entered the arena in the late 1800s. Following a training in neurology, early collaborations with Breuer led to publications on hysteria (Freud and Breuer, 1893, 1895), laying the groundwork for his understanding of the neuroses and defence (Freud, 1894), and the future development of psychoanalysis, and modern approaches to psychotherapy.

During this same period, however, and as a result of his training as a neurologist, Freud was drawn towards attempting a scientific analysis of consciousness, memory and perception from a functional and biological perspective, in an attempt to lend scientific credibility to introspective, subjective and philosophic approaches to understanding consciousness and the mind. This led to his *Project for a Scientific Psychology* (1895 [1950]), which he shared in draft form in letters to his friend Fliess (trans., Masson, 1985), but which he never published during his lifetime after realising the limitations of neuroscience in understanding neuronal processes in his day. The *Project* was finally published posthumously in 1950, and has been belatedly recognised as an impressively ambitious work dealing with many issues relevant to modern neuroscience, as we shall see later (Holmes, 2020; Woody and Phillips, 1995; Lothane, 1998).

At that point, Freud returned to what became his primary focus, clinical work, and the complexities of relational processes that lead to mental illness and dis-ease. Central to psychoanalysis is the understanding that our relations to the world, which principally means to other individuals, or to people collectively, leads to conflict as a result of seeking pleasure, or avoiding pain. As noted above, Freud’s *pleasure principle* was presaged by Leibniz’s realization, some three centuries earlier, of the importance of what impressions *mean* to a recipient; that it is feelings of satisfaction or unease that determine action choices. In this sense, both Leibniz and Freud implicitly recognised feeling to be an essential attribute of being conscious; in the case of Freud this is stated explicitly in the form, “It is surely of the essence of an emotion that we should feel it, *i.e.* that it should enter consciousness. ... for emotions, feelings and affects to be unconscious would be quite out of the question” (Freud, 1915, p. 126). Recent developments in neuroscience also recognize the importance of feeling and *affect*, as themselves being the essential qualia of consciousness itself (Solms, 2019).

Freud took the implications of conflict within relationships further than anyone had done previously, developing theories of repression where mental contents too threatening to the ego are held in the unconscious, still active, but not consciously so, essentially as counterparts to conscious experience. Freud’s pupil, Jung, later formulated the same mechanisms in his own conception of the *shadow*, of which the subject is not consciously aware, as counterpart to the consciously experienced outward-facing *persona* (Jung, 1912).

For readers who wish to understand more of the development of Freud’s ideas and theories, many books have been written, including a readable overview by Phillips (ed., 2006). In the remainder of this section, limited by space, post-Freudian understandings of early infant development are chosen as exemplars (in the broadest sense) of psychoanalytic understandings of the subject-object nature of relationships, the roots of language, and inter-relationships between an inner world of affect and

subjectivity, with an outer sensory world.

Outer-Inner, Early Infant Development and Subjectivity

Freud recognised the crucial role of early experiences with primary care-givers, particularly the mother, in facilitating or hindering an infant's development of a healthy, stable and resilient ego. "Infant-observation" of a baby in interaction with its mother during the first two years of life is, for many psychotherapists and analysts, one of the most powerful aspects of their training to help understand early development of the sense of "I". A baby's cries or scream, initially a bodily reaction to hunger, and the response of a carer, are key experiences for a baby to start to develop a theory of mind, beginning to distinguish self from other, to form a self-representation.

Initially, a mother's smile invariably and mostly automatically elicits a smile in return from a very young baby, facilitated by a class of mirror neurons in the infant brain that are particularly active in the early months. The baby's smile exactly mirrors what the baby sees, and since sensory pathways are at first amodal, the baby also experiences in its body some of the mother's pleasure behind the smile. At this stage, the mother and baby appear to some extent to be psychologically merged. Such interactions, if repeated consistently, help strengthen a stable and pleasant sense of subjectivity in the baby, while, at the same time, unavoidable moments of difference between baby and mother lead to a dawning realization that mother is "different", is "other", leading to gradual development of a self-representation, of being a subject, different to mother, an "I".

The Language of Relationship

Through early experiences of satisfaction or frustration in role procedures between mother and baby, both parties learn to relate action (cries) to response (attention/feeding), and if interactions are sufficiently consistent, outcomes become predictable. Interactions which at first are almost entirely bodily-based, gradually give way to inner self-referred feelings within the control of the developing baby, laying the basis for a sense of "I" which can be satisfied. The self-representation, then, originally rests heavily on bodily interactions, and we might expect an underlying dependence and interplay with bodily sensations to persist in most, perhaps all, processes of thought. As Freud noted in *The Ego and the Id* (1923) "The ego is first and foremost a bodily ego". As we shall see in the section on Buddhism below, the crucial role of the body is rediscovered by meditators, and to a large extent replaces dependence on external sensory input in approaching jhāna meditation.

If interaction with a person, object or idea is perceived as not threatening to the stability of the self-representation, perhaps even strengthening or enhancing it, it may be "owned" or accepted as part of the "I" construction at that time. The inner sentence of the thought which perceives the external person, object or idea will contain the subject as "I", and the sense of satisfaction or identity achieved is experienced as pleasant feeling. This almost inevitably leads to some degree of *attachment* and the search for repetition, all part of maintaining the self-representation, and which are key concepts in post-Freudian psychotherapy.

The burgeoning "I" and awareness of "other" are the beginnings of a grammar of relationship. The baby quite quickly realises that actions (e.g. crying) elicit a response, introducing action as verb; and as the subtlety of the early reciprocal relationships develop, conditionals and other elements of grammar follow. What at first is implicit behavioural understanding, eventually becomes linked to sounds and syllables as signifiers of meaning, and the familiar structures of speech develop.

This description of a self-representation is close to Freud's early use of the term "I" or ego in the *Project* (1895, pp. 322–3), where he describes "[processes] of 'wishful attraction' and...

'repression' lead to 'an organisation'... called the 'ego'" (Freud's emphasis). Here, Freud's recognition of repression leads to a quite different emphasis in his work towards understanding psychological disorders, neuroses and psychoses, compared to philosophical attempts to understand consciousness and cognitive processes preceding psychoanalysis. Situations where interactions with the "other" are stressful or unbearable to the self-representation led him to consider the manner in which human beings seek to psychologically defend themselves from such threats to their self-image, and in one of his letters to Fliess regarding his *Project*, he commented "All I was trying to do was to explain defense" (letter to Fliess, 16 August 1895; in Masson, 1985, p. 136).

The Grammar of Defence

In echoes of Leibniz's "primal language of thought", Freud had his own fascination for language in the early years that set the scene for his development of psychoanalysis, "... words which we use in our everyday speech are nothing other than watered-down magic. But we shall have to follow a roundabout path in order to explain how science sets about restoring to words a part at least of their former magical power (Freud, 1890, p. 283).

In his understanding of how language develops, Freud recognised how the grammar of language mirrors psychological processes of defence – the ways in which painful feelings and conflict are avoided or repressed. If an object, person or idea threatens the stability of the self-representation (i.e. the subject), processes of defence come into play and the response experienced by the subject may be disowned or rejected as not-I. In the sentence of thought there is flexibility in where the "I" is placed, if it is placed at all, and it may well be that all of us are neurotic in the sense that we *manipulate the grammar* of thought (or "lie" to ourselves) to maintain our self-representation. In this sense a psychotic may be said to have forgotten or never learnt the grammar.

The role of language was articulated most clearly in Freud's (1911) treatment of the *Schreber* case, a study of paranoia, where Freud analysed the symptoms in terms of their grammatical implications. His approach can be described as propositional analysis of the ways in which the basic proposition "subject–verb–object" can be transformed to hide or distort an underlying (threatening) meaning. For example, in a painful situation that leaves a person vulnerable in their self-representation to feeling utterly unlovable, the subject might immediately remove themselves from the sentence of thought to re-establish a more familiar and stronger self-representation (this would be Freud's "primary *thought defence*" to "direct the cathexis of attention *elsewhere*" (*Project*, Freud, 1895, p. 382, Freud's emphasis). Or, the subject might change the grammar to "I am *not* unlovable" (negation or denial); or to "*you* are unlovable" (reaction formation); or to "*he* is unlovable" (displacement), and so on. If direct defences such as these are difficult, perhaps because the person fears from previous experience that they are *in fact* unlovable, then more complex changes to the sentence may mean that it is so radically changed that the experience is "forgotten", but only at the price of another sentence or "symptom".

Various other theorists have enlarged on the role of grammar in defence, following Freud (e.g. Suppes and Warren, 1975; Dennison 1997).

Overall, while Leibniz equally placed language as central to consciousness and to the interactions between inner experience and the outer world, Freud adds the additional dimension where interactions between subject and the world can become dysfunctional and lead to pathology, mirrored in linguistic constructions. In a similar vein, neuroscience models of active inference (see section below on neuroscience) that describe action choices made by an "organism" to minimise free energy and to reduce prediction error, have gradually evolved to recognise possibilities of dysfunction that

correspond to many of the understandings of pathology within psychotherapy and psychoanalysis (Holmes 2020).

BUDDHIST MEDITATION

The Dalai Lama and others have commented on more than one occasion that “Buddhism is more than a religion, it is a science of mind”, with its main tools lying in sophisticated meditation practices to explore the processes of thought, cognition and consciousness. Such practices are ultimately aimed towards freeing practitioners from dysfunctional attachments as a result of living within a complex and demanding sensory world, rooted in craving, wanting or not wanting, and leading to unhappiness and mental suffering. The most direct practice to unravel such attachments has been, for over two millennia, the practice of *jhāna* meditation, whose specific techniques allow practitioners to progressively disengage, albeit temporarily, from sensory consciousness, to facilitate insight. This is done initially by redirecting attention inwards away from engagement with sensory inputs, to a meditation object typically the breath, and eventually towards the mind itself or more precisely towards the *qualia* of consciousness. The resulting *jhānas*, sometimes described as states of absorption, are stages of increasing simplicity and stillness where, without the distractions of sensory consciousness, insight into the nature of reality may be achieved.

Both practitioners and scholars have written about the *jhānas* as they are described in Buddhist suttas and commentaries dating back over two millennia (Cousins, 1973; Gunaratana, 1980; Brahmali, 2007), and some have recognised the potential of their practice as a living laboratory for understanding the mind and brain. Wallace (1999), referring to the *samatha* tradition and the practice of *jhāna*, comments that, “The mind and consciousness itself are the primary subjects of introspective investigation within the Buddhist tradition”.

In addition to Buddhist suttas, *Abhidhamma* texts, sometimes referred to as *higher doctrine* or Buddhist psychology, composed around the third century BCE, 200 years after the Buddha’s death, contain detailed descriptions of what is referred to as 5-door sense consciousness, as well as “mind-door” and *jhāna* consciousness. The Pāli terminology may be off-putting, but they deserve patient attention as remarkable examples of sophisticated models of thought processes based on meditative introspection (Cousins, 1981; Lancaster, 1997; and Harvey, this volume).

In this section we focus on the first four *jhānas* of form, the *rūpa jhānas*, which were the subject of the EEG study of meditators (Dennison, 2019) to be described shortly in this chapter.

The First Rūpa (Form) Jhāna and Disengagement from Sensory Consciousness

It is helpful to look at the *jhānas* alongside another closely related classification within Buddhist practice, the *Bojjhaṅgās*, or Factors of Realization (Dennison, 2020). Table 1 below lists the two systems alongside each other; in the left-hand column are the seven *Bojjhaṅgā* factors, and in columns 2-5 are the factors for each of the four *rūpa jhānas*; in the original Pāli terminology, with English translations. The *Bojjhaṅga* factors are viewed as developing interactively with each other as a person practices any of the core Buddhist meditational traditions, but the essential starting point is *Sati*, or mindfulness, in interaction with *Dhamma-vicaya* or investigation. These two *Bojjhaṅgā* factors are closely related to the first two *jhāna* factors, *vitakka* and *vicāra*, and together they describe a detailed development and re-direction of attention, necessary to develop the 1st *rūpa jhāna*.

Sati, mindfulness, is typically established by directing attention towards a meditation object, which for the purposes of our discussion will be the breath, either as it moves in and out of the body, or its sensation at the nose-tip. The mental act of placing attention on the breath establishes a reference

point in time and space, which corresponds to the jhāna factor vitakka, placing attention. A novice meditator then has to contend with distraction and wandering attention to develop the second jhāna factor, vicāra, sustained attention, which requires a degree of investigation on the part of the meditator to know from moment to moment exactly where his/her attention is, to be able to restrain even the slightest impulse towards inattention. This kind of attention and effort describes the quality of Dhamma-vicaya, which requires interest, effort, and a wish to understand, alongside simply bare mindfulness. In practice this requires greater awareness of sensation and feelings, adding a quality of salience to mindfulness.

The Bojjhaṅgās Factors of Realization	Rūpa (Form) Jhānas (RJ) and their Factors			
	RJ1	RJ2	RJ3	RJ4
Sati Mindfulness	Vitakka Placed attention	(Vitakka)	(Vitakka)	(Vitakka)
Dhamma-vicaya Investigation	Vicāra Sustained attention	(Vicāra)	(Vicāra)	(Vicāra)
Viriya Vigour				
Pīti Energisation (“joy”)	Pīti	Pīti energisation	(Pīti)	(Pīti)
Passaddhi Tranquilisation	Sukha	Sukha	Sukha Happiness, bliss	(Sukha)
Samādhi Concentration/ Absorption	Ekagattā One-pointedness	Ekagattā	Samādhi Absorption, concentration	
Upekkhā Equanimity				Upekkhā Equanimity

Table 1 Jhāna factors and the Buddhist factors of realization

As attention stabilises on the breath, becoming essentially automatic as impulses towards distraction, thinking and “naming” fade, a degree of contentment, satisfaction and more energy develops as the burden of keeping going all the processes of everyday sensory consciousness lessen. This subtle happiness is sometimes resisted to begin with before meditators learn to trust it, but it presages full development of *sukha*, happiness or bliss, in the 3rd rūpa jhāna. At this stage, attention is progressively transferred to an internal mental object, referred to in the jhāna texts as the *nimitta* (Wallace, 1999; Cousins, 1973) or “sign”, which is the meditator’s growing sense of his/her own consciousness; one might say the “qualia” of that consciousness. From this point on, concentration and mindfulness deepen towards one-pointed absorption, or jhāna. In Table 1, column 2, the jhāna factors vitakka and vicāra are listed bold to indicate they are the dominant factors of the 1st rūpa jhāna. Secondary factors are pīti, sukha and ekagattā, usually translated as energisation or joy, happiness or bliss, and one-pointedness, respectively.

The 1st rūpa jhānas is a crucial milestone for a meditator, as it marks success in disengaging from habitual sensory consciousness. This disengagement is referred to many times in Buddhist suttas by the description, in Pāli: “vivicc’ eva kāmehi paṭhamam jhānam upasampajja vihāreti”, which translates as, “Apart from sense desires, [he/she] attains and dwells in the first jhāna”.

Working with attention is the dominant activity in developing the first jhāna, and is required to be developed to a high level, often over years of practice. This suggests that the attention networks

of the brain might be the first to be disrupted during the early stages of developing jhāna, which turns out to be the case, even remarkably so, with the two aspects of attention in the jhāna tradition, vitakka and vicāra, corresponding well to the two attention streams recognised in neuroscience.

The Second Rūpa Jhāna

Following relative mastery of attention in developing the 1st rūpa jhāna, development of the 2nd, 3rd and 4th rūpa jhānas is more concerned with feeling, and the underlying subject-object nature of consciousness rather than the more mechanistic cognitive processes of attention. As soon as we consider the nature of a subject-object interaction, we find we are dealing with feelings and the *meaning* of experience for a subject's self-representation, as both Leibniz and Freud both recognised as features of what we refer to as the default sensory consciousness. In fact, even to develop the first rūpa jhāna, meditators already find themselves working with resisting attachment to liking and disliking, in Buddhist terms the roots of craving and the source of suffering, and in psychoanalytic terms the cause of conflict, repression and defence. A crucial part of disengaging from our habitual sensory consciousness requires disengagement from this enmeshment with habitual comparison and conflicts between wanting and not-wanting if the higher jhānas are to be developed.

Subjectively, the movement from the 1st to the 2nd rūpa jhāna is characterised by a growing sense of peace and contentment at the increasing freedom from dependence on DCs processes. Confidence increases, and the interest and wish-to-know of the second Bojjhaṅgā, Dhamma-vicaya (investigation), develops into energised interest and determination, reflected in the third Bojjhaṅgā *virīya*, or vigour. Although there is not a direct equivalent to viriya in the jhāna factors, in the Bojjhaṅgās classification viriya is followed by *Pīti*, energisation, which is listed in both classifications, and which is the dominant factor for the 2nd rūpa jhāna (Figure 1, column 3). Secondary factors are sukha, happiness, and ekaggattacitta or one-pointedness, as in the 1st rūpa jhāna.

The EEG study to be described strongly suggests this factor is related to increased availability of energy that would previously have been tied to maintaining the complex cortical networks supporting the default sensory consciousness, and the “I” self-representation.

The 2nd rūpa jhāna is all to do with mastering the energisation of pīti, experienced particularly in the body to varying degrees ranging from prickling of the hairs on the head or body, through to subtle or stronger vibration (Dennison, 2020). Some practitioners describe it as a sense of the body waking-up, and the task in the 2nd rūpa jhāna is to fully experience this process, and to learn by doing how to tranquilise the energy into a deeper experience of mind/body integration towards deeper concentration, leading to the absorption of jhāna. *Passaddhi*, tranquilisation, is recognised explicitly in the Bojjhaṅgas as the fifth factor in that classification.

The Third and Fourth Jhānas

The 2nd rūpa jhāna is the foundation for the 3rd. Once pīti, energisation, has been balanced by passaddhi, tranquilisation, into deeper stillness, there remains no disturbance at all in the body, paving the way for simply deep mental happiness, *Sukha*, to remain as the dominant factor of the 3rd rūpa jhāna. In the fifth-century Buddhist text the *Vimuttimagga* (Upatissa), the subjective experience of the 3rd jhāna is described as “fully conscious”, for the first time if it is the first experience of the state. Subjectively, the experience “fully conscious” is as though nothing is left out of the experience, that mind and body have integrated into a state of deep peace described by the jhāna factor *Samādhi*, which together with sukha are the characterising factors for the 3rd jhāna. It replaces the factor ekaggattacitta, one-pointedness, of the 1st and 2nd jhānas, and is sometimes translated as

concentration. It is much more than that, however, an experience of deep peace and absorption, with a growing underlying basis in wisdom. It is also the sixth factor of the Bojjhaṅgās classification.

In terms of disengagement from the default sensory consciousness, this means no remaining disturbance, in either body or mind, due to wanting or not-wanting, anything other than the deep peace of the 3rd jhāna experience. In contrast to the sensory consciousness of “this” or “that”, meditators describe their subjective experience as fully aware, embodied presence. In the EEG brain study, as the 3rd and 4th jhānas develop, the sensory consciousness networks distributed across the head gradually become still, leaving a single dominant region of activity at the crown of the head. The implications of this for understanding jhāna consciousness will be described later in the chapter.

For a meditator becoming familiar with the 3rd rūpa jhāna, it may be difficult for quite some time to imagine a more refined state. However, there may come a time when even happiness starts to become seen as a disturbance, when a meditator becomes aware of an underlying subtle attachment to the “reward” of happiness. This opens the way to the 4th rūpa jhāna where any residual attachment, even to happiness, is let go leaving an experience and depth of stillness free of any attachment or craving whatsoever.

Again thinking of the degree of disengagement from sensory consciousness, it could be argued that it is only in the 4th jhāna that a practitioner succeeds in becoming fully detached, for its duration, before withdrawing back to sensory consciousness and everyday life. The profundity of the experience differs from the samādhi of the 3rd jhāna in its additional quality of freedom - from the burden of keeping going the processes of sensory consciousness that support our sense of “I”. This is recognised by the jhāna factor *Upekkhā*, usually translated as equanimity as the closest approximation to a state of deep peace, perfect concentration and absorption, together with a quality of wisdom. *Upekkhā* is also listed as the seventh Bojjhaṅgā, or Buddhist factor of enlightenment.

Breaking the Cycle of Dependence

In the discussion so far, a common factor across the modalities of philosophy, psychoanalysis and Buddhism has been recognition of the importance of feeling, liking or disliking, attachment and craving in determining action choices. This is clear in Leibniz quotes L3, L4, L8 and L9; as leading to conflict and repression in psychoanalysis; and as craving being the root cause of suffering in Buddhist theory.

In Buddhism this is referred to as the cycle of dependent arising (Figure 1). Various starting points can be used to describe different features (Gethin, 1998), but *Avijjā*, not knowing, is frequently

used as representing a primary restlessness leading to engagement with the sensory world. This engagement is not just with present input, but also past experiences (Kamma formations), leading to consciousness characterised by subject–object duality, the sense bases, contact with the outer world or ideas, feeling leading to liking and/or disliking, craving, attachment, and then action (becoming), which could be mental or physical in nature, or both, leading to a whole new set of parameters,

Figure 1 Buddhist model of dependent arising

inevitable conflicts between satisfaction or dissatisfaction, i.e. suffering – and the cycle repeats.

The purpose of jhāna meditation is to break this cycle; to give a meditator an experience of temporary freedom from this largely unconscious process. This insight into a deeply habitual cyclic process lying behind our engagement with the sensory world, has many similarities to the cyclic nature of active inference processes in modern neuroscience, described in the following section.

NEUROSCIENCE

Free Energy and Active Inference

Beginning in 2010, Karl Friston’s free energy theory rapidly evolved into detailed models of “active inference” with far-reaching implications for understanding how individuals, as biological self-organising systems, adapt to living in a sensory world (Friston, 2010; Seth and Friston, 2016). Simply put, the human brain receives sensory inputs from “outside”, from our environment, in particular via sight, hearing and touch, and from our body via interoceptive biological and nervous system signals, all then processed incredibly quickly and mostly unconsciously, in relation to past experiences held in memory, leading to action choices.

For a self-organising system to be viable, to survive and resist entropy processes that would otherwise lead to dissolution or chaos, means that the action choice needs to assess all possible options to make the most efficient use of available energy, to minimise free energy, while at the same time minimising prediction error, “surprise” or unexpected shocks to the organism, and ultimately to keep entropy within bounds (Guevara, 2016).

Figure 2 illustrates this process. Inputs include sensory inputs (left) from the external world, together with bodily sensations, and interoceptive and nervous system inputs via the brain stem. These

Figure 2 Schematic of adaptive active inference processes

inputs are processed (right), leading to action choices based on prior experience. The chosen action then feeds back to update the “priors”, and the cycle repeats with continuously updating inputs. Friston (2018a) points out that for active inference to be effective in minimising prediction error, the inference process must have a temporal depth linking memories of past experiences to current information from the world, and to predictions of future outcomes, which “necessarily lends (active)

inference a purposeful and self-centred aspect that has the hallmarks of consciousness (and necessarily implies self-consciousness because I am the author of my actions)". He contrasts this with situations of reduced consciousness or minimally conscious states where stimulation may elicit only a reactive response or "surprise" in the "here and now", and which cannot respond to simulation tests that require an imaginal time course.

These developing models of adaptive active inference highlight the interactive nature by which individuals are influenced by their environment, and through their actions influence and change that same environment in a never-ending dance. The arena for this dance is the sensory world, with a continuous flux of reciprocal interactions with others and with associated emotional impacts.

Sentience, Subjectivity and Consciousness

In what began as a highly mathematical, statistical and probabilistic treatment of self-organising systems, it quickly became clear that intent and "agency" is implicit in determining action choice, bringing it ever closer to the question of subjectivity and consciousness on the part of this agent. Referring to Kruglanski *et al*'s (2018) work on cognitive consistency, Friston (2018b) comments that "a consistent belief about what to do identifies one course of action unambiguously over all plausible alternatives. Conversely, inconsistency corresponds to an uncertainty about what to do that is generally associated with negative affect and - in the context of interoceptive inference - stress, anxiety, and negative emotion".

These developments in active inference theories that action choice will be strongly dependent on prior experiences and their emotional impact, whether a choice is attractive or disliked, is consistent with Leibniz's and Freud's views on the importance of what an experience "means" to the subject; in other words whether the choice supports or threatens the likely subjective experience of "I am" or "I do". Likewise the recognition by both Freud and Leibniz of the importance of order and a time course to support consciousness, in their views supported by language.

Whilst previous neuroscience research focused on trying to identify brain networks that might have the capacity to elicit consciousness, the free energy principle and active inference suggest that consciousness as agency might be an inevitable property of self-organising systems. Most recently, Solms and Friston (2018) enlarge on this and hypothesise three forms of consciousness: affect consciousness; perceptual consciousness; and reflective consciousness; distinctions that we will return to after discussing implications for consciousness based on the EEG study of jhāna meditation.

2. DISRUPTION OF THE DEFAULT SENSORY CONSCIOUSNESS TOWARDS JHĀNA CONSCIOUSNESS

This section is based on the first in-depth and peer-reviewed EEG study of jhāna meditation reported in Dennison (2019), to which readers are referred if they require further clarification, particularly as regards equipment and methodology. This was a within-group study of 29 experienced lay meditators (19 men, 10 women) from a total pool of around 400 in the UK, Ireland and the US (falling under the auspices of the Samatha Trust, regd UK Charity, 1974, no. 266367; www.samatha.org), recorded during 2014-18, including some re-recorded after 1-3 year intervals. Twenty-four of the subjects were of graduate or postgraduate-levels of education, and more than half had held, at one time or another, senior professional roles in health-care or education. Four had spent temporary periods as ordained Buddhist monks in Thailand.

Although years' experience of meditation ranged from 4-40+ years, subjects varied considerably in their experience and degree of mastery of jhāna, and in order not to rely too heavily on subjective views as to which jhāna meditators felt they might have been experiencing, the study focused instead on *themes* of EEG activity that emerged across this broad group of meditators as they attempted to develop ever-deeper stages of meditation. In effect, the material constitutes a series of case studies describing electrophysiological changes in the EEG; in particular, spindles, infraslow waves, spike-wave bursts and clonic seizure-like activity, never previously observed in other (more mainstream, non-jhāna) researched forms of meditation.

Epochs of these features were observed in every subject to a greater or lesser degree, and the neural correlates of each of these themes were analysed first in sensor space (raw electrical EEG activity at, typically, 31 sensors across the head), and then by the computational reverse-solution algorithm of sLoreta (Pascual-Marqui, 2002) to identify underlying cortical sources responsible for the surface activity; i.e. an analysis in source space.

The following sections are structured around three EEG themes, believed to relate to disruption of the default sensory consciousness as affected by the stages of jhāna meditation: spindles; infraslow waves; and spike-wave or seizure-like phenomena.

SPINDLES, ATTENTION AND THE 1ST RŪPA JHĀNA

All of us in the eyes-closed resting state show EEG rhythms in the alpha (α) band (centred on ~10 Hz), mostly around the back of the head (Figure 3), which typically become much reduced when a person opens their eyes to engage with the outer world, particularly through vision, being then replaced by faster beta (β) rhythms (14-25 Hz) related to thinking and cognitive processing.

For many years in neuroscience, the α -rhythm has been regarded as an “idling” rhythm

Figure 3 An EEG example of spindles

reflecting a generally relaxed state. Spindles are wave-packet-like disruptions of this rhythm, and Figure 3 is an example of how they appear in the EEG during the approach to jhāna.

In Figure 3, electrode labels (left) are coded according to an international system where Fp denotes frontal-polar sites, F frontal, T temporal, C central, P parietal, O occipital. A1 and A2 are

reference electrodes at each earlobe (Figure 4). The EEG analysis is initially made in *sensor space* (i.e. based on surface scalp electrodes), with electrical signals measured at either 21 or 31 sites (corresponding to two different amplifiers used on different occasions for comparison and to rule out equipment artifacts). The traces at the top of Figure 3 are from the front of the head, moving downwards to the back of the head, with time in secs in the yellow bar. For this meditator the spindles are mostly around the back of the head, and the lower enlarged section shows the typical wave-packet nature of the spindles.

In neuroscience spindles are well-known to occur in the approach to sleep, but also in cases of attentional distraction (such as a driver attending to the road while distracted by conversations in a car), and to a lesser extent in the early stages of anaesthesia. In sensor space, as in Figure 3, meditation spindles are quite different to those in sleep, or anaesthesia, or attentional-distraction. They are more prolific ~20/min compared to ~2/min in sleep; lower frequency ~7-10 Hz compared to sleep spindles 10-14 Hz; and lower frequency than the normal α rhythm of 8-12 Hz centred on 10 Hz, typical of spindles in attentional distraction or anaesthesia (Dennison, 2019). And, crucially, meditators are not drowsy or asleep, but on the contrary are highly alert.

Figure 4 Scalp electrodes

Since the development of spindles in meditators' EEG is the most common theme by far, shown by 27 of 29 subjects to greater or lesser degrees, it was hypothesised to be related to the early stages of developing jhāna; i.e., the approach to the 1st rūpa jhāna. As described earlier in the section on Buddhist meditation, meditators are required to develop their understanding and mastery of attention, and to redirect their attention from sensory stimuli to the more inner meditation object, in this case the breath during ānāpānasati meditation (mindfulness of in- and out-breathing), and that in the jhāna tradition this is understood to involve two aspects of attention: *vitakka*, directed attention; and *vicāra*, sustained attention. The question then arises as to whether this ancient understanding of attention in Buddhist theories of jhāna, might have some relation to modern neuroscience understandings of attention networks in the brain.

To explore this question, an analysis in *source space* was carried out to identify the cortical sources underlying spindle activity in meditation; this was applied to 18 independent recordings showing spindles with the highest density and clarity of form. While the reader is referred to Dennison (2019) for greater detail, the cortical sources that were identified confirmed that meditation spindles represent disruption to the two underlying cortical networks, familiar in neuroscience, known as the dorsal and ventral attention/perception streams (Figure 5 below).

The dorsal stream, sometimes referred to as the “action” stream, carries moment-to-moment information about objects and sense impressions; while the ventral stream conveys richer representations of the “world”, feelings and salience. The former is the more basic aspect of attention in the sense of initial contact, a moment in time, and corresponds well to the jhāna factor *vitakka*, placing attention; while the ventral stream which establishes context and salience similarly corresponds well to the more feeling-based salience aspects of *vicāra*. In other words, the language of jhāna corresponds well to modern neuroscience in declaring this central role of attention.

We therefore conclude that spindles represent meditators' growing success and mastery of attention in resisting the pull, or attachment, to their sensory consciousness in developing an approach to the first rūpa jhānas, which all meditators have to pass through before developing the higher jhānas.

In this study, no preference was found for the dorsal or ventral paths, with both streams represented almost equally across meditators in the balance of cortical sources underlying spindling. This may relate to the fact that this particular meditation tradition follows a model of 4 rūpa jhānas, where vitakka and vicāra are developed together in the 1st rūpa jhāna, rather than an older and less well-known model of 5 jhānas, where vitakka is mastered in the 1st rūpa jhāna, then vicāra in the 2nd, with the 3rd, 4th and 5th jhānas corresponding to the 2nd, 3rd and 4th in our 4-jhāna model.

Figure 5 Dorsal and ventral attention/perception streams of neuroscience

In this study, no preference was found for dorsal or ventral paths; both being represented almost equally across meditators in the balance of cortical sources underlying spindling. This may relate to this meditation tradition following a model of 4 rūpa jhānas, with vitakka and vicāra developed together in the 1st jhāna, rather than an older and less well-known model of 5 jhānas where vitakka is mastered in the 1st jhāna, then vicāra in the 2nd, with the 3rd, 4th and 5th jhānas corresponding to the 2nd, 3rd and 4th in our 4-jhāna model. It would be interesting at some point to test the 5-jhāna model, to examine whether the dorsal and ventral streams would be

affected sequentially as meditators move from the 1st to the 2nd jhāna in the 5-jhāna model.

Even so, the results were sufficient to suggest that vitakka, the first stage in redirecting attention, represents the basic stage in disengaging from default sensory consciousness (DCs), and likely corresponds to Kanai *et al.*'s (2015) first-order driving process in predictive active inference. Vicāra then becomes the next “higher-order” level of attention affecting the salience networks of attention.

INFRASLOW WAVES (ISWs) AND THE 2ND AND HIGHER RŪPA JHĀNAS

The second theme in the EEG recordings was the appearance of very slow rhythmic activity for about 21 out of 29 subjects, to varying degrees, with approximately half of those cases showing high amplitude and highly developed rhythmicity, as in the example shown in Figure 6.

Superficially similar to slow waves in the deepest stages of sleep, anaesthesia or coma, these very slow rhythms observed during meditation were significantly slower, hence referred to as infraslow waves (ISWs), in some cases reaching levels of intensity unprecedented in existing neuroscience research. The 1-min excerpt in Figure 6 from an experienced meditator shows intense ISWs particularly across central regions, and the two inset intensity maps that correspond to the start and end-points of the yellow-highlighted segment show an alternating pattern of excitation-inhibition as the ISWs ebb and flow across the head, with a strong focus near the crown of the head. This localised focus, in this case just posterior to the vertex, was observed for other subjects who showed strongly developed and extensive ISWs, and will be shown later to be an early indication of a developing new vertical axis of jhāna consciousness. The scale, right, shows that the ISWs in this example reach peak-to-peak intensities >1000µV (far larger than typical slow-wave intensities ~150-

250 μV in deep sleep or coma), and the rhythm has a periodicity of $\sim 10\text{-}15$ secs.

Across eight meditators, including this subject, who showed strong and well-defined ISWs, a mean frequency ~ 0.125 Hz was found, with some evidence of an even slower rhythm $\sim 0.02\text{-}0.05$ Hz. Such frequencies are far slower than the slow waves $\sim 0.8\text{-}1.2$ Hz (related to the heart rhythm) seen

Figure 6 Meditation infraslow waves (ISWs); subject 24, 2017

in deep stage-4 nREM (non-rapid eye movement) sleep, or in anaesthesia or coma. Since these latter modes are regarded as unconscious states, the appearance of ISWs in meditation raises intriguing questions as to the kind of consciousness that develops in this form of meditation.

In several examples, remarkable levels of intensity were observed far higher than in sleep as noted above, but also as far as this author is aware far higher than in any recorded examples of even high-voltage low-frequency slow waves in coma. Some subjects recorded intensities >2000 μV (2500 μV in one case), mostly around the crown of the head, levels completely unprecedented in neuroscience apart from some extreme pathological states. Compared to typical EEG resting-state levels $\sim 20\text{-}30$ μV , an ISW amplitude ~ 2500 μV corresponds to a voltage ratio $\sim 100\text{:}1$, equivalent to a power ratio (V^2) $\sim 10,000\text{:}1$, an increase of four orders of magnitude; which may relate to some meditators reporting prickling sensations across the top of the head. In the published paper, these high levels of energization were interpreted as manifestations of the *jhāna* factor *pīti*, *energization*.

The ISW examples in Figure 6 affect frontal (upper-trace) sites earlier than sites towards the back of the head, in effect “travelling” across the head in a similar way to some slow waves observed in deep sleep. Across different meditators who show travelling ISWs, transit times vary, but an example analysed in more detail in Dennison (2019) showed mean transit times of: frontal (Fp1) to occipital (O1/O2), 593 ± 300 ms; frontal (Fp1) to temporal (T5), 723 ± 230 ms; and frontal (Fp1) to central-midline (CPz), 1278 ± 340 ms. The mean front to rear transit time ~ 600 ms corresponds to a mean transit speed ~ 50 cm/sec across the head, significantly slower than typical values $\sim 1.2\text{-}7.0$ m/sec for sleep SWs; another difference between meditational and sleep slow waves.

UNDERLYING CORTICAL SOURCES OF ISWS

As with the previous spindle analysis, cortical sources were computed using eLoreta for seven

recordings showing the strongest and most consistent examples of ISWs (>2500 secs of EEG in total). Sources are summarised in 3-D source space in Figure 7, where the labels B6, B10 etc. are the conventional cortical Brodmann areas of neuroscience. For this whole sub-group of experienced meditators, the source plots, left to right, show three regions of interest (ROIs). At left, frontal areas include frontal and fronto-polar sites B10 and B11, extending upwards towards the vertex at B8, amounting to 24.1% of the total activity.

Figure 7 ISW cortical sources from 7 independent recordings (>2500 secs)

The second ROI includes the three central plots showing strong intensity around the vertex, bridging the frontal-parietal divide, amounting to 44.4% of total activity. At right, the third ROI includes temporal and occipital activity amounting to 11.7% and 19.8% respectively.

Across this sub-group of experienced meditators, the vertex ROI accounts for almost half of the total neuronal activity, and Figure 8 is an example of how this vertex, crown-of-head activity can develop to completely dominate the EEG at deeper levels of jhāna.

Figure 9 illustrates how as experience in jhāna meditation develops, so too does the vertex ROI become stronger. The top panel for the same subject shown in Figure 8, recorded in 2014, shows strong frontal and occipital ISWs, and the inset scalp maps of the intensity across the head at the start and end-points of the yellow-highlighted section reveal a small hotspot just posterior to the vertex. Three years later in 2017, now with more experience of practicing jhāna, the lower panel for this same meditator shows a vertex source that now completely dominates the EEG activity, while the ISWs show a significant correlation with the breathing rhythm (lower trace, red).

Figure 8 Sagittal section and 3-D cortex plot of the vertex ROI, subject 5, 2017 (600 sec sample; 0.016-150 Hz)

3-D plots of the underlying cortical sources computed from a longer (600-sec) sample from 2017 show this dominance more clearly in Figure 9, where all distributed network activity appears to have been gathered into the vertex source. To quantify this rather remarkable observation, an

e-Loreta source analysis was carried out for both 2014 and 2017 recordings, to identify *all possible* contributing sources from the strongest to the weakest, in total 31 independent components (ICs) corresponding to the various permutations of the 31 electrode signals.

Figure 9 ISW activity; subject 5, 2014 (upper panel) and 2017 (lower panel)

This analysis was carried out across the full bandwidth 0.016-150 Hz, to include all recorded brain activity, resulting in the summary shown in Table 2, where SFG, MFG and IFG refer to the superior, medial and inferior frontal gyri; PCL and PCG the paracentral lobule and postcentral gyrus; and Cun and MOG the cuneus and middle occipital gyrus of the brain. The vertex dominance revealed in source-space is far stronger than the surface activity alone would suggest. While already highly dominant in 2014 at 92.8% of the total signals' variance, by 2017 this percentage had increased to an extraordinary 99.7%, with only weak residual activity remaining at frontal and occipital sites. In a further analysis of frequency structure (Dennison, 2019) for the 2017 recording, the vertex source was found to be overwhelmingly made up of ISW activity in the frequency range 0.02-0.13 Hz, against a far smaller (ratio <1:15,000 in spectral power) background of broadband λ activity extending beyond 100 Hz.

The vertex dominance revealed in source-space is far stronger than the surface activity alone would suggest. While already highly dominant in 2014 at 92.8% of the total signals' variance, by

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2014 % contribution to total EEG signals' variance	Source locations	2017 % contribution to total EEG signals' variance
5.7%	Frontal B11, B47 SFG, MFG, IFG	0.2%
92.8%	Vertex Fronto-parietal B4, B5, B6, B7 MFG, SFG, PCL, PCG	99.7%
1.5%	Occipital B18, B19 Cun, MOG	0.1%

Table 2 Breakdown of all possible independent cortical sources as % of total signals' variance. Subject 5, 2014 and 2017; 600-sec recording, bandwidth 0.016-150

In a further analysis of frequency structure (Dennison, 2019) for the 2017 recording, the vertex source was found to be overwhelmingly made up of ISW activity in the frequency range 0.02-0.13 Hz, against a far smaller (ratio <1:15,000 in spectral power) background of broadband λ activity extending beyond 100 Hz.

In other words, the scaled structure of δ , θ , α , β , activity² typical of our default sensory consciousness had effectively disappeared, which raises the question, what kind of consciousness does this jhāna meditational state represent? We will return to this question soon.

THE 2ND AND HIGHER RŪPA JHĀNAS

Recalling the discussion of jhāna factors in the earlier section on Buddhist meditation, the first two factors vitakka and vicāra were described as the working ground for developing some mastery of attention to begin to disengage from sensory consciousness and to approach the 1st rūpa jhāna; and the EEG study shows a correlation to the attention/perception streams of neuroscience.

The 3rd jhāna factor, pīti, is the characterising factor of the 2nd rūpa jhāna, and has not been well-understood in the history of Buddhist meditation. Many academic studies translated it loosely as “joy”, when in fact it is not part of the feelings group in the Buddhist Abhidhamma, but is rather part of the bodily formations group. In the oral traditions of teaching jhāna, it is recognised as an activation or “waking-up” of the body characterised by increased energisation and heightened bodily sensations. The high-energy ISWs observed in the EEG study are interpreted as manifestations of this developing pīti, and mark a deeper separation from the DCs than that characterised by spindling, heralding approach to the 2nd rūpa jhāna, and subsequent development of the 3rd and 4th jhānas.

In this interpretation, meditators showing only spindling would correspond to the approach stages and development of the 1st rūpa jhāna. Those showing both strong spindling *and* ISW activity

² Early in the history of EEG it was realised that electrical activity fell into frequency “bands” rather than spread across all frequencies, which gave rise to the following conventions: delta δ band ~1-4 Hz; theta θ band ~4.5-7.5 Hz; alpha α band ~8-12 Hz; beta β band ~15-30 Hz; and gamma λ band ~35-150 Hz or higher.

would be developing their experience of the 1st and 2nd rūpa jhānas. While those showing strong ISWs with either no or weak spindle activity would be consolidating their experience of the 2nd rūpa jhāna. And those where powerful ISW activity dominates as in Figures 8 and 9 would be developing the 3rd and 4th rūpa jhānas, culminating in the near absence of δ , θ , α , β and other default consciousness EEG activity, leaving just fully developed ISW activity near the vertex with only very weak background gamma λ as shown in Table 2.

The experience of strong pīti is always accompanied by heightened bodily sensitivity, and in some cases meditators report “waves of pīti” moving across the head, which may relate to the observation that the strongest ISWs exhibit a travelling nature, as noted earlier, as they drift across the head, mainly on a front-back or back-front axis, in sensor space.

SPIKE-WAVES AND SEIZURE-LIKE STATES

Spike-Waves

The third EEG theme was the occurrence of occipital spike-waves for some meditators, as in the bottom-right corner of Figure 6, but seen more clearly in the expanded extracts for four meditators shown in Figure 10 below.

Figure 10 Meditation spike-waves

waves, which includes key areas of the primary visual cortex, we regard their occurrence as reflecting disruption to the “I/Eye” occipital-thalamic feedback loop, and further evidence of disruption to the default subject-object nature of our DCs. In this hypothesis, the primary visual cortex at the back of the head is the site for the subject “I/eye” pole (Merker, 2013), whereas frontal cortex sites perform

Spike-waves in neuroscience are normally associated with absence epilepsy, mostly in children, while in meditation they occur spontaneously for some meditators without disturbing their meditation, quite different to unconsciousness in absence epilepsy. Meditation spike-waves also differ from those in epilepsy by occurring only at occipital sites, both in sensor space and source space, whilst those in epilepsy are more widespread. The dominant underlying cortical sources are at posterior Brodmann sites B17, B18 and B19 (lingual gyrus, middle occipital gyrus, and cuneus), as in the lower panels of Figure 10 for subjects 1 and 7, accounting for over 88% of the total EEG activity.

The “spike” nature of this form of activity is understood in neuroscience to be controlled by the thalamus, and given the occipital dominance for meditation spike-

the object function via their well-understood role in cognitive processing (Petersen and Posner, 2012); the two interacting via recurrent connectivity, which we would suggest plays a key role in the active inference process (Figure 2). The regions of interest shown in Figure 7 show the frontal-occipital subject-object axis, and the increasingly dominant vertex axis of jhāna consciousness.

Meditation spike-waves also differ from those of absence epilepsy in that the dominant spike frequency varies between different meditators, mostly in the range 3.5-6.5 Hz, whereas in absence epilepsy the frequency tends to be fixed close to 3.5 Hz. Meditation spike-waves also display *harmonic structure*, unlike in epilepsy, as shown in the examples in Figure 10 where the dominant spectral peaks are listed above each trace with the harmonics underlined. The harmonic structure can even be seen with the naked eye in the raw recordings, as higher frequency rhythms between spikes – similar to “ringing” or reverberation.

Since it is the thalamus that controls the scaled δ , θ , α , β frequency band structure we see in our everyday sensory consciousness, we believe that these harmonics are evidence that the thalamus in fact has a *repertoire* of discrete frequencies that become apparent when meditators disengage from the DCs disrupting the default scaled structure. As far as I am aware this is the first direct demonstration of harmonic structure, and some implications will be discussed in the section below on Brain Networks.

Instability

In the older jhāna traditions of Southeast Asia, sometimes referred to as the Yogāvacara or *Boran Kammathāna* (traditional meditation practices; Crosby, 2000, 2013), the development of pīti is regarded as central to full development of the jhānas, and a range of intensities are described from minor tingling, goosebumps or prickling of hairs on the head or body, to powerful shaking or even in some cases jumping in the air from a cross-legged position. The task in developing the 2nd rūpa jhāna is to become familiar with pīti such that it becomes incorporated into a deeper experience of mind-body integration, or samādhi. If this process goes well, subjects are able to contain very high energy states with no discomfort whatsoever, as in the examples already mentioned where some meditators sustain ISW intensities at the vertex 10,000 times normal resting-state levels.

In the Yogāvacara (and Tibetan yoga), specific techniques allow meditators to deliberately evoke such highly energised states to the point of instability. The rationale is to master this ability, and to then tranquilize that energy or pīti back into deeper absorption. Repeated practice builds confidence and reduces fear, enabling meditators to maintain equanimity even during powerful bodily reactions, and to then calmly integrate that energy into deeper samādhi. To an observer, clonic features (physical manifestations) develop similar to epilepsy, but without discomfort, and the state can be evoked or left at will. To the meditator these are simply expressions of pīti that has become unstable for a while, and Figure 11 shows an example from an experienced meditator.

The first sign of growing energisation in this example is development of occipital spike-waves (lower left), followed by a brief $\sim 1/2$ sec global burst, a second 3 secs later, another ~ 7 secs later, and then the main body of the “seizure” 15 secs later. Physically, the subject shows jerks and vibration mainly along a vertical axis.

The expanded view shows the occipital spike-waves, and a related and near-sinusoidal rhythm at the right temporal site T6 (interestingly, temporal lobe epilepsy is one of the most common variants of epilepsy), reaching a remarkable peak-to-peak intensity ~ 3000 μV . At right are the two strongest underlying cortical independent components (ICs) for the main yellow-highlighted event, showing intense, localised activity at right-hand occipital sites, with a spike-wave frequency 5.62 Hz, together

Figure 11 An example of seizure-like activity. The posterior part of the yellow-highlighted extract is expanded below, with the two main cortical sources and their spectra (right)

BRAIN NETWORKS, HARMONIC AND FRACTAL STRUCTURE

In the scaled frequency structure of our default consciousness, DCs, the alpha (α) rhythm (roughly 9–11 Hz) performs a central role, in effect as the *signature* of sensory consciousness (Dennison, 2019). Its ~ 100 ms periodicity is close to the human reaction time, with implied involvement of sensorimotor networks in readiness for action. In that sense it performs the key time-synchronising role within our default consciousness, and is the *scale-factor* underlying the δ , θ , α , β and γ frequency bands of the normal human EEG (Figure 12).

Figure 12 Scaled frequency bands on linear and log plots

In Figure 12, the δ , θ , α , β and γ frequency bands of our default sensory consciousness, DCs, are shown, together with those for sleep slow waves (SWs) and for the ISWs of jhāna. The centre frequencies with error bars are also

with temporal activity at the harmonic, 11.23 Hz.

The fact that such control is possible in this form of meditation we believe is due to highly developed attention and absence of fear; related to relative mastery of the first two jhāna factors vitakka and vicāra, and raises the question as to whether some of the features of this training might be of help for epilepsy sufferers to mitigate the frequency of epileptic seizures.

These frequency bands reflect independent but highly interconnected functions. For example, α activity might be said to characterise a minimum duration for perception to action, referred to in Dennison (2019) as the basic unit of a “conscious “thought”. Faster β activity would then represent underlying faster unconscious cognitive processes; whilst slower θ activity might allow more than one α processes to be integrated together, facilitating memory; with γ representing the most rapid functions, as yet not fully understood.

In Figure 12, the δ , θ , α , β

shown on a log scale, and the points for sleep SWs, and the δ , θ , α , β and γ frequency bands, all fit well to a straight line, indicating a power-law scaled frequency structure for our default consciousness (see also, Klimesch (2013)). However, the points for jhāna are separated by more than four standard deviations from the straight line, confirming our earlier conclusions that jhāna (unlike sleep) does not represent a subset of sensory consciousness, and is a quite distinct mode.

These conclusions regarding scaled structure are supported by recent theoretical studies of hierarchical self-organisation in the brain (Friston *et al.*, 2020a), where such structure is shown to be an inevitable consequence of nested hierarchical Markov blanket interactions. Friston *et al.* also coin the term “cognitive moment”, as their equivalent to our basic unit of cognitive thought.

In a further nuance to this discussion, the harmonic structure of meditation spike waves was interpreted in Dennison (2019) as related to disruption of the scaled structure of our default consciousness, triggering the thalamus into harmonic activity revealing a repertoire of frequencies in an attempt to re-establish scaled network activity. If this interpretation is correct, it strongly suggests that harmonic or *fractal structure* is likely to be integral to thalamo-cortical connectivity, and that the δ , θ , α , β frequency structure of the DCs is but one example, presumably optimal for sensory consciousness and energy balance, and biologically and evolutionary favoured for optimal response to threat and for species survival (Klimesch, 2013). Again, these results are entirely consistent with Friston *et al.*'s theoretical treatment (*ibid.*)

The α scale-factor may therefore be considered an *attractor*, a term used in chaos theory, that allows otherwise scale-free “chaotic” neuronal activity to coalesce into the DCs networks that reflect engagement with the sensory world. The attentional disruption evidenced by spindles as meditators withdraw from their DCs thus reflects the beginnings of failure of the α -attractor, leading to new network dynamics. As jhāna deepens with further withdrawal from the DCs, powerful ISWs develop and networks simplify further; first to near-midline frontal and occipital hubs with a developing vertex ROI (Figure 7), which, as the higher jhānas develop, eventually becomes the dominant ROI composed of highly focused ISW activity as shown in Figure 9. At this stage, δ , θ , α and β activity typical of the DCs is virtually absent, with only weak high-frequency gamma activity as background to the ISWs.

JHĀNA CONSCIOUSNESS

We are now in a position to summarise the consequences of a person disengaging from their default sensory consciousness, DCs, while developing jhāna meditation. Re-directing attention away from the sensory world towards an inner meditation “object”, at first the breath and later the quality of consciousness itself, is the crucial first step, with EEG spindling a consequence of disruption to default attention networks in the brain. This fundamental role of attention in engaging with sensory consciousness was highlighted earlier in this chapter when discussing Leibniz', Freud's and modern neuroscience views of everyday consciousness.

Moving beyond the 1st rūpa jhāna depends not just on mastering attention, but increasingly resisting attachment to value judgements relating to our “I” construct; liking or disliking, wanting or not-wanting. Network activity begins to simplify to regions of interest at frontal, temporal and posterior sites (Figure 7); where the frontal and posterior activity is hypothesised as the remaining traces of the subject-object networks of default sensory consciousness, and the temporal contribution the residual part of the ventral perceptual stream. At the same time, a new focus of activity develops at the vertex, eventually dominating cortical activity in the deeper development of the 2nd and higher jhānas.

Whilst pīti, the third jhāna factor developed in the 2nd rūpa jhāna has always been an intriguing and somewhat puzzling factor to Buddhist scholars, it takes on a new significance in the light of insights based on the two disciplines together, ancient jhāna and modern neuroscience. As a meditator disengages from sensory consciousness and cortical networks simplify, less energy will be required to support those very same networks that underpin our default sense of “I am” and “I do”, with a consequent increase in available energy which was hypothesised in Dennison (2019) as manifesting in the energisation of pīti, reflected in the high intensity infraslow wave activity progressively developing around the vertex. This is an interesting counterpart to the minimisation of free energy as the driver of self-organisation (Friston, 2010) underpinning our default consciousness, revealing a previously unrecognised and very large reservoir of available energy when the DCs networks are disturbed (recall the 10,000:1 increase in EEG power at the vertex in some cases).

The 3-D source map of the vertex hub (Figure 9) is then the first demonstration, ever, of jhāna consciousness, represented by a vertical axis down through the brain stem into the body, quite different to the widely distributed networks of the DCs.

We can now turn to meditators’ subjective experiences of jhāna. Without exception they describe the experience as quite different to their everyday consciousness, which is dominated by cognitive processing, naming and language, liking and disliking. The experience of jhāna is more all-encompassing and freer of the constraints of language, one of embodied “presence” rather than feeling conscious of “this” or “that”, as in default sensory consciousness. Within “presence”, there is still awareness of being a self, but with progressively less attachment to the conventional “I-tag” (Lancaster, 1997), or persona of the default consciousness.

The experience is one of deep and almost timeless stillness as a consequence of the much slower time-scale ~8–30 secs of ISW activity (related to the scale-factor of the respiration cycle) compared to the ~100 ms time-scale (mean reaction time) of our DCs; that is, two orders of magnitude slower. This may be the reason that *samatha*, the overall discipline within which the jhānas are practiced, is described in Buddhist texts as undisturbed peace or tranquillity.

Yet, by definition, consciousness still requires an object to be conscious of, so what kind of consciousness is this? In the oral jhāna tradition two views have been expressed: in the first, each moment of consciousness becomes the object of the next, giving the illusion of perfectly still, continuous undisturbed consciousness. This is envisaged as a high-level and very fast process, and we might wonder at the role of the background gamma activity (Table 2, and earlier discussion) as well as brief gamma bursts sometimes observed at key transitions where meditators are given a cue to move to the next stage of their meditation (Dennison, 2019). This may imply a very fast flickering between moments of jhāna absorption (see also Harvey, this volume), each followed by an immediate reflection on the state, before re-establishing absorption. We might also consider that it represents a highly stable state of reciprocal top-down–bottom-up recurrent processes, described in the free-energy formulations of modern neuroscience (Seth and Friston, 2016), where the error between prediction and current state has been reduced to effectively zero, at least for a while.

A second view is that the body itself is the supporting object of jhāna consciousness, as part of a deep metabolic integration, and perhaps related to the intriguing term “*body witness*” encountered in ancient texts such as the Vimuttimagga or Visuddhimagga (Upatissa 3rd century; Buddhagosa, 5th century). Interestingly, some recent theorists (e.g. Solms, 2019) suggest the upper brain-stem rather than the distributed cortex may be a vital part of core consciousness processes; perhaps as a bridge between brain neuronal processes and the body’s nervous systems (see below).

A New Axis of Consciousness

The near-vertex hub described above encompasses Brodmann sites, B6, B5 and B7, which include the supplementary motor area (SMA), strongly connected to the thalamus and projecting directly to the spinal cord, and the highly connected medial parietal associative cortex, believed to be widely involved in high-level processing tasks, with dense links to the underlying cingulate, thalamus and brain stem. We might also include the role of the anterior cingulate cortex, which in recent theoretical work on active inference and predictive coding relates *presence* to agency (Seth and Friston, 2016), with resonance to meditators' descriptions of "vivid presence" during the deeper stages of jhāna.

This vertical-axis connectivity is striking in contrast to the (suggested) front-back axis of the DCs (Figure 7), and suggests involvement of the ascending reticular activating system (ARAS; Maldonato, 2014), and related processes of arousal, attention and consciousness, as well as the processes of top-down–bottom-up recurrent processes in active inference (Seth and Friston, 2016.) It is known that disruptions to the ARAS can lead to coma, and disruption of posterior cingulate connectivity can cause unconsciousness (Herbet, 2014), yet the forms of disruptions we see in jhāna meditation do not lead to unconsciousness, even though the strong ISWs have superficial similarities to deep sleep and coma, as discussed earlier.

The development of the vertex brain-body axis, rather than the frontal-occipital axis of the DCs, together with evidence of even slower underlying ISW activity $\sim 0.02\text{--}0.05$ Hz described in Dennison (2019), suggests an even slower metabolic scale-factor integrating the entire mind-body system in the deeper levels of jhāna. Such extreme low frequencies suggest a deep metabolic link to the much slower rhythms of visceral bodily processes, and a likely link to the tree-like extensive vagus nerve networks in the body that control the major organs and the balance of the sympathetic and para-sympathetic nervous systems (Figure 13).

Such extremely slow activity may correspond to the slow alternations seen in fMRI/BOLD imagery of subjects in the resting state (Grooms *et al.*, 2017), and to Friston *et al.*'s (2020a) recent theoretical findings that ultraslow waves are an emergent property of scale-invariant behaviour.

A consequence of such a deep metabolic brain-body link in this form of meditation might also be expected to result in a shift in the body's autonomic nervous system balance towards a degree of enhanced parasympathetic activity, with a reduction in underlying tensions of the potential fight-flight reactions of the sympathetic system. Heart-rate variability (HRV) is sensitive to this sympathetic-parasympathetic balance, since when sympathetic activity is strong, the adrenaline system readies the body for action and the accompanying tension causes the heart rate to become more fixed with a reduction in inter-beat variability.

Figure 14 below is a preliminary test of this hypothesis on two of the subjects from the original study, re-recorded in 2019 with their electrocardiogram (ECG) alongside their EEG. The measure adopted of HRV is RMSSD, the root-mean-square of the time differences between successive R-R peaks (left panel), values of which are shown in the bar chart (right) as the subjects moved from the eyes-closed (EC) non-meditating condition, into meditation. The bar chart shows increases of 75-

Figure 13 Brain-body systems, conceptual illustration

100% in HRV, strongly suggestive that the subjective experience of “embodied presence” in jhāna is an experience of deep peace, both in the body as much as the mind.

Figure 14 Left: an ECG segment showing the R-peaks of the heartbeat; right: changes in HRV from before to during meditation

3. MARKOV BLANKETS AND HIERARCHIES OF “CONSCIOUSNESS”

In the previous sections two forms of consciousness have been described, both essentially “human”, but differing in their subjective experience. The first, and most familiar to us, is our everyday consciousness lived within since birth, described as a default mode of consciousness. This mode is one of interaction with other individuals and the external world primarily by sensory inputs and sensorily-based communication, hence the designation human default *sensory* consciousness, DCs. The second form, jhāna consciousness, is revealed when an individual intentionally disengages, temporarily, from their default sensory consciousness when practicing the method of jhāna meditation.

In the following section we introduce the concept of the Markov blanket, as a prelude to hypothesising an additional more extensive and outermost Markov blanket system that encompasses planet Earth as the outer environment, with global societies and structures as the inner states.

MARKOV BLANKET HIERARCHIES

For anything to “exist”, whether at the smallest cellular level, up through hierarchies of biological organisms, human beings and even societies, it has to be distinguished from its environment by a boundary, which in statistical probabilistic theory is termed a Markov blanket (an evocative term coined by Judea Pearl, a computer scientist and philosopher, in 1988). Without a boundary, a prototype entity would simply dissipate, or “die”, in accordance with the laws of entropy and thermodynamics (see Kirchhoff *et al.*, 2018, “The Markov Blankets of Life”).

The concept of the Markov blanket has been a highly creative extension of the free-energy and active-inference literature. Initially this approach focused on self-organisation in the brain, in so far as the human being and outer sensory world constitute a fundamental Markov blanket system central to our lived experience. Information transfer from outside to inside is in the form of *sensory* inputs, which lead to *action* choices by which inner states influence the outer world (Figure 2). It is because these are two quite different modes of information transfer that conditional independence is maintained; states internal and external to the Markov blanket can only influence each other indirectly, and the Markov blanket is the locus for the sensory and active states.

Furthermore, theory predicts the existence of “nested” Markov blankets at different hierarchical levels of organisation, which in the brain translates to ensembles of neurons separated by a Markov blanket from a larger ensemble, up through a hierarchy of scales replicating an overall structure similar to the scaled frequency structure of our default sensory consciousness (Friston *et al.*, 2020a). There may be a virtually unlimited number of individual Markov blanket systems for different assemblies of neurons in the brain, and the discussion so far suggests that it is the whole brain system in relation to the outer world that carries our experience of default sensory consciousness.

Although, as noted above, states “outside” and “inside” each Markov blanket are conditionally independent from each other, two information geometries allow a statistical and probabilistic “communication” between outer and inner states via blanket states. Readers may be surprised we choose to describe this as communication, yet if active inference is to be effective, there has to be a meaningful “dialogue” or exchange of information, to allow inner states to make appropriate action-choices that will minimise “surprise”, uncertainty or prediction error for the organism. In the next section we explore these forms of “communication”, and implications for consciousness.

“COMMUNICATION” AND FORMS OF CONSCIOUSNESS

Default Sensory Consciousness (DCs)

As described in Section 1, the characteristics of the DCs mode are relatively well-understood from a subjective perspective across a wide range of disciplines, as cognitively-determined, mediated by language, and as supporting our sense of “I am” and “I do”. As human beings, our first experience of this mode as a Markov-blanket system is the nine months in the womb, where the developing foetus is independent from its external environment within the boundary of the amniotic sac, yet dependent on external conditions, i.e. the body of the mother, to maintain homeostasis. We might expect that during pregnancy, the information geometry or “communication” across the mother-foetus Markov blanket system will be mostly via biochemical and interoceptive channels, although ultrasound studies of twins during the later stages of pregnancy show clear evidence of purposeful inter-twin interactions (Castiello *et al.*, 2010).

As discussed in Section 1 (psychoanalysis), the interactions following birth are crucial in establishing a stable and healthy ego, and are particularly influenced by mother-baby interactions in the first two years of life, which form the subject matter of “infant observation” studies for psychoanalysts in training (Dimarco, 2013). Such interactions, if repeated consistently, help strengthen a stable and pleasant sense of subjectivity in the baby, while, at the same time, the unavoidable moments of frustration between baby and mother lead to a dawning realization that mother is “different”, is “other”, leading to gradual development of a self-representation, of being a subject different to mother, and the beginnings of an implicit understanding of subject-object *positions* in the grammar of relationship. In terms of active inference, a minimum level of consistency is necessary to minimise “surprise” or shocks to the developing sense of subjectivity of the infant, which is what Winnicott (1953) referred to as being a “good-enough” mother.

The information geometry from outside states to blanket states conveys *sensory* information from the outside world, which then results in a different information geometry based on possible *actions* for the inner states, i.e. the baby, in relation to the outside world, the mother. Provided the mother is sufficiently responsive, the baby quickly learns that certain actions, e.g. crying, illicit a response, and the grammar of relationship extends to subject-*verb*-object reciprocal interactions which become learnt routines within the neuroscience processes of adaptive active inference.

Conditionals soon develop, and the grammar becomes more complete and language begins to be expressed verbally.

The forms of communication and the developing sensory consciousness of the baby are therefore heavily sensorily-determined, and increasingly underpinned by language. Early infant development is also a rather beautiful example of Kirchhoff *et al.*'s (2018) statement that it is an integral feature of Markov blanket theory that over time, "an organism [in this case the baby] will become a model of its environment" [in this case the mother].

Jhāna Consciousness

The central feature in developing jhāna is disengagement from sensory consciousness (DCs) which, in effect, means stepping outside the active-inference networks that constitute the individual-societal Markov blanket structure. In terms of EEG brain activity, the two modes are quite different in their frequency structures. That of jhāna is characterised by infraslow waves (0.03-0.125 Hz) and very weak background gamma (λ) activity, with the intermediate δ , θ , α and β bands of the DCs absent in the deepest levels of jhāna (Figure 12). Also, whilst the DCs is supported by widely distributed cortical network activity, with subject-object processes related to frontal-posterior cortical interactions (Figure 7), a quite different vertical axis from the crown of the head, down through the brain-stem into the body develops during jhāna meditation (Figures 9, 13).

The two modes of consciousness differ very significantly in time- and spatial-scales. The time scale-factor of jhāna, ~10-30 secs, is 100-300 times slower than the ~100 ms time scale-factor of the DCs; and if we take an approximate figure ~1/2-1 cm for a localised cortical network in the brain, compared to body size ~1.7 m, then the spatial ratio is very similar to the ratio of time-scales. As already noted, this is consistent with Friston *et al.*'s (2020a) theoretical findings that ultraslow waves and hierarchical scaled structure are natural consequences of self-organisation in the brain.

It is also of interest to note how this change of scale comes about, which, from the discussion in Section 2, is likely to begin in the early stages of developing jhāna, through disruption of the dorsal and ventral attention/perception streams which encode the "when" and "what" attributes, and therefore the time and spatial scales, of our default sensory consciousness (Friston and Buzsaki, 2016). As jhāna progressively develops, those DCs scales transform into the ~100-300x slower and larger time and spatial scales of jhāna consciousness.

It is consistent with the much greater spatial scale, and much slower time scale-factor, that jhāna consciousness is experienced subjectively as almost timeless "presence", and more all-encompassing of the whole person: brain, body and mind (hence, "embodied presence"), where we use "mind" as a less limited term than the experience of "I" in the DCs, closer perhaps to a core sense of self. It is also entirely possible, based on the EEG findings of a vertical axis from the crown of the head, that this sense of embodied presence is supported by upper brain-stem processes similar to those hypothesised by Solms (2019) as the source of affect consciousness (see section to follow). However, affect consciousness as the most basic aspect of our default sensory consciousness arises as a response to sensory input from the outer world, whereas jhāna consciousness only arises when a meditator disengages from the outer sensory world. The most likely interpretation of this important difference would then be that it is *interoceptive* information about the condition of the body's nervous and visceral systems that constitutes the inputs that support the mental processes of jhāna; which also explains the 100-300x longer time scale factor of jhāna due to the much slower biological and visceral bodily processes compared to the rapid neural processes involved in sensory processing.

The subjective experience of *jhāna*, in this view, is then deeply related to interoceptive information from the body, which takes the place of sensory information from the “outer world” in the case of the DCs. And so long as the brain-body Markov blanket of *jhāna* consciousness can be maintained, with its almost timeless subjective equanimity, then in the language of free energy and active inference there will be no prediction error; all that is redundant, distracting or unnecessarily complex has been dissolved, with expected free energy absolutely minimised – until the driving intent behind establishing *jhāna* comes to a natural close, in some cases after a few minutes, in cases of great experience potentially hours.

Referring to the example of sleep, Friston *et al.* (2020b) describe this return to a default state (to the DCs in the case of waking from sleep) as a return from “periods of disconnection from blanket states... [drawn by] a pullback attractor” (p. 23); which would correspond to the alpha (α) attractor we hypothesised in Section 2. In the case of *jhāna*, the attractor might be thought of as the 100-300x slower time scale-factor of visceral and bodily metabolic processes.

“Consciousness” More Broadly

The most recent developments in neuroscience focus on how “consciousness” might be understood in the light of Markov blanket systems that are implicitly *directed* (i.e. via active inference), implying “agency” or subjectivity. In this context, Friston *et al.* (2020b) highlight the crucial importance of “temporal depth” in active inference, allowing a distinction to be made along a continuum from simple non-conscious systems which have only a rudimentary and short-term reflexive information geometry across their Markov blanket, for example a virus, up to human beings who have a far more extensive and complex information geometry across the Markov blankets separating us from the larger world, whose considerable temporal depth allows us to select actions that consider long-term consequences.

This distinction between temporally deep and shallow generative models in active inference suggests that the gradient between unconscious and conscious states might well be gradual, which is not inconsistent with our daily experience within the DCs of sleep-wake transitions, or the wide range of levels of clarity or concentration that we experience in daily activities. This graded feature of human consciousness was also recognised by Leibniz (Section 1, L2 and L6).

Solms and Friston (2018) and Solms (2019) go further in linking subjectivity to the arousal processes well-known in neuroscience that define wakefulness, and, more precisely suggest that it is our capacity to *feel*, and experience affect, that constitute consciousness; i.e. that feelings and affect are *exactly* the qualia of consciousness. This resonates with Buddhist understandings of *jhāna*, where the process of disengaging from sensory consciousness begins with resisting cognitive processes of thinking, and redirecting attention inwards to the *felt* qualia of consciousness itself, termed in the *jhāna* literature as the mental “sign” or *nimitta* as the refined counterpart to the sensation of the breath.

Building on Solms and Panksepp (2012), Solms and Friston (2018) suggest affect consciousness to be the most basic or core form of (DCs) consciousness, and that it is dependent on arousal and interoceptive awareness of the body; and that it is not necessarily self-reflective. They locate the upper brain-stem as the physiological locus for affect and this most basic form of consciousness. Cortical activations build on affective consciousness, via attention to an idea or sensory input, leading to perceptual consciousness, which corresponds to a basic subject-object structure; and further reflective re-presentations facilitated by language lead to thinking and what they term cognitive consciousness; which we might equally term self-reflective consciousness, when the subject becomes aware of being the subject of his/her own consciousness, therefore answering the

question of the “hard problem of consciousness” (Solms, 2019). It is noteworthy that Leibniz’s view of consciousness being the result of reflection on a perception (L1, Section 1), three centuries earlier, is essentially the same.

The Illusion of “I”

The above discussion challenges simplistic views of “conscious” versus “unconscious”, and highlights the importance of temporal depth in active inference as allowing what might be seen as a continuum of “consciousness”, at least as a form of directed agency. And in the case of our everyday sensory consciousness, Solms and Friston’s (2018) suggested taxonomy of affect consciousness, perceptual consciousness, and reflective cognitive consciousness further clarifies the subtle roles of perception and reflection as components of our subjective experience.

In contrast, *jhāna* consciousness experienced as “presence”, is hypothesised as an integrated brain-body interaction underpinned by interoception rather than sensory input from a superordinate external world. Subjectively, as the *jhānas* develop and as “presence” deepens, the “I-tag” (Lancaster, 1997) weakens, yet consciousness if anything becomes more all-encompassing and vivid the less it depends on “I am”. This is consistent with Buddhist views of our sense of “I” as an illusion, and that its temporary removal in *jhāna* opens the way to deeper insight into the human condition.

Neuroscience may well be converging with this view of the illusory nature of “I”, in that the third stage of Solms and Friston’s (2018) taxonomy where reflective re-presentations lead to self-consciousness, might easily morph into adding a cognitive (illusory) construct of “I”, particularly if the cognitive re-presentations attach to the imaginal structure of one’s own body as “I” or “mine”. A rather similar allusion is made in the Buddhist “Puppet Simile”³ described in the 5th century *Vimuttimaggā*). It might then be argued that both Buddhist and active inference models support the view that the cognitive conclusion that “I am” and “I do” is both impermanent and has no ultimate reality. However, there are many advantages to the continuity of this illusion, particularly in the ability to predict outcomes from past experience; the bodily satisfaction of the baby; protection of the body of the adult when under threat; and as the self-representation develops, to protect its integrity. So there develops a near-automatic process of maintaining this sense of “I am” and “I do”.

A GLOBAL MARKOV BLANKET, GAIA CONSCIOUSNESS AND CLIMATE CHANGE

Beyond individuals and society, it is a logical next step to consider an outer Markov blanket system of societies worldwide in interdependence with our planet, as conceptualised in Figure 15, which is a satellite view of planetary weather systems with subordinate levels of cities and peoples.

At this outermost scale of the planet Earth, and societies and life on Earth, what might be said about information geometries and the equivalent of communication or information transfer that we can recognise across other Markov blanket systems? If the same principles of Bayesian and active inference processes apply at the global-societal level, with corresponding information geometries, we are tempted to refer to a level of Gaia “consciousness” to borrow a term first coined by Lovelock and Margulis (1974). However, in doing we use the word consciousness in a much looser sense than so far; certainly not affect- or interoceptive-based as in the DCs or *jhāna* modes, although we wonder

³ “... these puppets are called bodies; the master of puppets is the past defilement by which this body is made complete; the strings are the tendons; the clay is flesh; the paint is the skin; the interstices are space. [By] jewels, raiment and ornaments [they] are called men and women. Thoughts [of men and women] are to be known as the tugging by the element of air. Thus they walk, dwell, go out, or come in, stretch out, draw in, converse or speak.”

whether “disturbance” might be appropriate in the theme of information transfer and self-similarity across the global-societal Markov blanket – see below.

Whilst most Markov blanket research has focused on brain networks, the mathematics is applicable across multiple hierarchical scales, and should apply to all examples of “life”. Indeed, common themes recur across hierarchies. For example, Friston *et al.* (2020a) describe the “recursive procedure by which successively larger scale (and slower) dynamics arise from subordinate levels”, with “implicit self-similarity of particular dependencies ... in moving from one scale to the next” (p. 9); here, “particular dependencies” refers to the two information geometries that comprise Markov blanket interactions between outer and inner states.

Figure 15 Hierarchical Markov Blankets for Human Life

Similarly, Friston *et al.* (2020b) find that “the intrinsic anatomy and dynamics (i.e., physiology) of internal states must, in some way, recapitulate the dynamical or causal structure of the outside world” (p. 13), which resonates to Kirschhoff *et al.*’s (2018) statement, noted above, that over time “an organism will become a model of its environment”.

We already have two very clear examples of such self-similarity. In the case of our DCs, starting with mother-baby, we observe repeated character traits and reciprocal interactions between individuals who interact, mediated by sensory communication and language. In the case of jhāna, the neuronal processes in the brain and visceral and parasympathetic activity in

the body appear to develop a deep metabolic integration, via interoceptive “communication”, which is self-evidencing for the duration of the jhāna experience.

Extending this to the outer encompassing level of a planet Earth–societies system, Markov blanket and Bayesian theory would predict a self-similarity between outer and inner levels, and there is already proven evidence of a link between chaotic and increasingly destructive climate change processes, on the one hand, and examples of species extinction and increases of pathogens at multiple sites worldwide. Examples are Pounds *et al.*’s (2006) study of widespread amphibian extinctions driven by global warming; and more recently Wu *et al.*’s (2016) review of evidence for climate change effects on pathogens, hosts and transmission processes, noting that on the extreme global scale the 1997-98 and 2015-16 *El Ninos* led to outbreaks of malaria and cardio-pulmonary syndromes; episodes of severe flooding were related to outbreaks of cryptosporidium, typhoid, cholera, lymphatic disease and haemorrhagic fever; heatwaves led to West Nile fever and increased morbidity and mortality from infectious respiratory diseases; and drought led to hantavirus pulmonary syndrome (HPS), increased risk of West Nile virus and transmission of the St. Louis encephalitis virus.

Also, quite apart from the occurrence of new pathogens, and in the case of flu-like viruses their apparent increased ability to mutate and hence frustrate immune-system response, the immune system response itself has recently been demonstrated to be less effective as a result of increased seasonal

and rapid climate variability (Liu *et al.*, 2020). All of which leads us to wonder at a possible link between unstable climate change and the recent Covid-19 pandemic.

THE COVID-19 PANDEMIC AND BREAKDOWN OF THE GLOBAL MARKOV BLANKET

While the processes of adaptive active inference that underpin our everyday default sensory consciousness by and large lead to a remarkably stable dynamic low-energy balance in the brain's neural activity, it is an open question as to the stability of the outer global–societal Markov blanket. It may be no coincidence that with the Covid-19 pandemic we are witnessing human suffering on a global scale, at the same time that we face catastrophic effects of climate change caused by our negligence as human beings towards our environment and planet.

Kirchhoff *et al.* (2018) consider the question of stability of Markov blanket systems as related to the dynamics of ensembles of Markov blankets. Here, a Markov blanket at a superordinate macroscale contains an ensemble of Markov blankets at a subordinate microscale, and for the larger-scale structure to become viable, i.e. self-evidencing, the subordinate Markov blankets must become self-similar to each other in order to act coherently in response to inputs from the larger macro system, leading to constrained active inference loops tending to minimisation of free energy. This is clearly the case for the superordinate Markov blanket of the collective brain's activity, where inner subordinate Markov blanket ensembles of neurons interact coherently with each other via information geometries, as evidenced by the resulting and consistent scaled frequency structure of our default sensory consciousness.

It is also clearly the case in the example of the mother-baby Markov blanket system mentioned earlier, which “contains” at the micro level many ensembles of subordinate Markov blanket structures for the baby's brain and body systems. Given a “good enough” mother, where “inputs” from the mother are sufficiently consistent to allow coherent physical and mental responses in the baby, then reciprocal active-inference loops lead to an autopoietic self-similarity between mother and baby.

This can also be seen at larger social scales where cities and countries develop patterns of behaviour and language unique to that macro group, as characteristics of their self-similarity.

Instability of Markov Blanket Structures and Breakdown of Adaptive Inference

However, for systems with a large and complex array of subordinate Markov blanket structures, Kirchhoff *et al.* recognise “two different yet complementary tendencies: an integrative tendency of a multiplicity of Markov blankets to self-organize into a coherent self-evidencing whole, and a self-assertive tendency to preserve individual autonomy” (2018, p. 8).

It is this self-assertive tendency which we hypothesize as threatening to the stability of the global-societal Markov blanket system. On a global scale, we have many examples of such behaviour, as evidenced in often destructive economic competition between countries; leaders of some countries who clearly suffer from severe personality disorders and various forms of psychopathology including narcissism and paranoia, leading to neglect and damage to their own inner Markov blanket peoples; and, in the context of this chapter, the refusal to share responsibility and act together across countries to reduce destructive climate change.

In the language of active inference, if global societies have developed too many competing self-assertive behaviours, then consistent deep temporal predictions suitable to satisfy competing demands, and required in active inference to maintain a stable superordinate Markov blanket, may become impossible. This would correspond to Kirchhoff *et al.*'s statement that “to remain alive an organism must avoid crossing terminal species-specific phase boundaries” (2018, p. 6).

Information Geometries and the Nature of Breakdown of the Global Markov Blanket

The information geometries for our everyday human consciousness, DCs, and for jhāna consciousness have been described as sensorily-based and interoceptively-based, respectively, and it is through those modes that, as quoted earlier, “[the inner] will become a model of its environment” (Kirchhoff *et al.*, 2018). Given the necessarily much longer time scale-factor (months or years), of a hypothesized Gaia “consciousness”, what kind of information geometry is likely across the global-societal Markov blanket system? Patterns and themes, or the symbolic level might be the most obvious answer, or fractal processes whereby information and meaning is reproduced and reconfigured at different scales across Markov blankets (Oseledchik *et al.*, 2016). This latter mode is what we have already described as the basis for the scaled frequency networks in neural EEG activity, and a fractal aspect to hierarchical correlation across scales has also been suggested by Friston *et al.*’s (2020a) theoretical models.

It may then not be coincidence that alongside the catastrophic out-of-control fires and flooding of recent years, undoubtedly related to climate change and global warming, that we find ourselves suddenly afflicted by a quite new form of invasive and deadly virus; one that causes high fever, and where the barriers of the human immune system become as ineffective as a city’s flood defences in being unable to prevent congestive lung disease and death in those most vulnerable. The language of correspondences between “out-of-control fires” and “fever”, or between floods and pneumonia, reminds us of distorted (tangential) speech in schizophrenia, a result of disengagement from reality similar to Freud’s (1924) description of how words become “things” in the approach towards psychosis. Indeed, the present parallels between climate breakdown and the Covid-19 pandemic may indicate something akin to a “psychotic breakdown” of the global-societal Markov blanket.

It may also be the case that “disturbance”, or the absence of disturbance, might play the equivalent role in Gaia “consciousness” as affect and interoception do in the default sensory consciousness or jhāna consciousness, respectively. A well-functioning global-societal Markov blanket would then correspond to a harmonious self-similarity, while breakdown of the Markov blanket system would be characterised by self-similar disturbances of both the outer and inner systems.

For those readers who find these fractal or theme-based forms of self-similarity difficult to imagine, here is a related example from a real-life scenario of how severe mental illness is managed in an inner city’s National Health Service, in this case the UK, but examples can readily be found worldwide. Multidisciplinary community mental health teams (CMHT) typically manage large case-loads of clients struggling with severe mental health issues, addictions and dual diagnosis, and team members face an ongoing challenge in trying to contain the pathologies and acting-out of their clients. A number of psychotherapists, including this author, who have worked to support such teams have been struck on many occasions by how at times of great organisational stress (usually political or financial pressures) CMHT members themselves, as well as their managers, might act out the very same pathologies their clients struggle with. Teams sometimes split against each other; a member might be scapegoated as ineffective or dangerous; and, most interestingly, a team member somehow suited to the role frequently becomes the “mad” member of the group, exhibiting what cannot be acknowledged by others in the team; and at the superordinate level managers typically become punitive and highly critical, or lapse into denial. It is as though pathology (“disturbance”) transfers across the hierarchies – mental health patients, the CMHT team, and management – in the same manner as predicted by Markov blanket theories of self-similarity (Dennison, 2012; Dennison and

Carson, 2008; Simpson, 2010; Thorndycraft and McCabe, 2008), but also, most significantly, both upwards and/or downwards in the hierarchy indicative of many conflicting agendas that interfere with joined-up collaborative working at all levels.

CROSS-DISCIPLINE LESSONS AND OPTIONS

There is growing evidence to support the view that the global Markov blanket has become compromised and may already be in a process of breakdown, as evidenced by catastrophic climate change at the planetary level, and increases in pathogens, including the Covid-19 virus, and damage to immune systems at the societal level. Yet the evidence from lesser catastrophes in the past is that we do not readily take responsibility for such destructive behaviours, or change those behaviours.

One of the key features of Markov blanket active-inference processes, perhaps *the* key feature, is the recursive nature of interactions between an outer environment and inner states. This is evident in the active inference schematic of Figure 2; the Buddhist cycle of dependent origination, Figure 1; and learnt reciprocal relationships in primary mother-baby interactions, and then in other repeated relational patterns familiar in psychotherapy. If interactions are basically benign, then active inference predictions can be generated with extensive temporal depth, and system stability maintained. If, on the other hand, conflicting agendas and self-assertive tendencies across countries prevent subordinate societal systems forming collaborative responses to signals from the planetary level, then in the language of active inference, prediction errors become unmanageable, and a well-functioning global-societal Markov blanket system is likely to break down.

The obvious course to remedy such a breakdown would be to facilitate greater cooperation between nations, which to a very significant extent has been forced by the need to develop a Covid-19 vaccine. In other areas, including climate change itself, self-interest and entrenched hostilities make cooperation very problematic. Perhaps the best example of cooperation is what develops between a mother and her child in the first years of life, and that visceral knowledge of mothering is something that distinguishes women from men. It is then perhaps not accidental that the most rigid, despotic and self-absorbed world leaders are men, in which case the gender balance is well-overdue to become better balanced.

It is interesting in this context that Gaia is a female deity, the Greek ancestral mother of life. It is also an intriguing side-effect of the Covid-19 pandemic that there is already visible evidence of reduced global pollution as industries are forced into inactivity, with less fossil fuel usage, much reduced air travel, and so on. Indeed, some might wonder whether we are being shown by Gaia what could and ought to be done. However, it might be well to bear in mind that in Greek mythology Gaia was preceded by Chaos, and whether a threatened breakdown or terminal phase-transition in the global-societal system might be a return to chaos. The real test will of course come when the crisis passes; will the drivers of greed re-emerge, even heightened in a rush to make up losses? Or can societies pause to reflect, to resist the habitual unconscious processes that led to this point; particularly the driver of greed, the greed for more and more profit, the greed to outstrip one's neighbour via global competition, no matter the cost.

4. CONCLUSION

Both psychoanalytic and Buddhist models of our default sensory consciousness recognise that liking versus disliking, or greed versus aversion, even hatred, are primary motivators for behaviour

and choice of actions (Dennison, 2019). Starting with Freud (1895), the approach of psychoanalysis has been to uncover processes of denial and defence rooted in fear or craving for satisfaction, effectively to make the unconscious conscious; processes described by Holmes and Nolte (2019) in the context of the more recent free-energy and active inference literature. Similarly, Buddhism locates the cause of human suffering as due to craving, in particular greed or ill-will inherent in attachment to a sensory world (Harvey, 2012); hence the central importance in Buddhist practice of jhāna meditation to disengage, at least temporarily, from enmeshment in the sensory world to achieve a less-conflicted perspective.

It is not the suggestion of this chapter that jhāna meditation might be any kind of remedy or balancing factor, particularly since its experience usually requires years of practice. However, the starting point to eventually develop jhāna, and indeed any of the core traditions of meditation, is mindfulness, which is not difficult to practice as evidenced by its value in easing mild to moderate mental health disorders (Huang, S.-L. *et al.*, 2015; Dunning *et al.*, 2018). In Buddhist practice, mindfulness means attending to the present, but to develop its full potential requires a degree of discrimination in resisting attachment to past patterns, and learning to deal with greed and fear that usually underlie wrong choices of action. This accords with anecdotal evidence from those familiar with its application in mental health, that the therapeutic relationship (which basically equates to healthy, mature communication) is a key factor in fostering reflective discrimination. In the aftermath of the current crisis, we might hope for a reflective and mindful space where societies as a whole can learn from these extremely painful experiences to moderate behaviour in the future. The challenge will be to encourage and demonstrate the potential benefits of reflective collaborative behaviour, before old habits re-establish themselves. The existential shock of the Covid-19 pandemic may provide a small window of opportunity.

Furthermore, as noted above, Markov blanket theory recognizes the danger of self-assertive (i.e. selfish) tendencies of competing subordinate systems (societies) as a primary threat to coherent self-organisation of hierarchical systems, with the ultimate threat being a catastrophic terminal phase boundary (Kirschhoff *et al.*, 2018). It is therefore difficult to imagine how the inner pole of the global–societal Markov blanket can relate consistently and stably to the outer planetary level *without* a shared endeavour. If societies that constitute the inner level are to be able to “make inferences about the outcomes of [their] own actions” (*ibid.*), they are *implicitly* required to function as a united agency.

As a final and more sombre reflection, it would be a mistake to dismiss these discussions of Markov-blanket systems, information geometries and consciousness as theoretical abstractions with limited application to real-world concerns. Certainly, for the brain itself, we live *within* a mostly stable and finely-tuned dynamic balance that has evolved over thousands of years to support our engagement with the world around us, and which we largely take for granted. However, the very same processes of adaptive inference and hierarchies of Markov blanket systems that support our personal lives, inevitably operate at both the micro-scale, indeed at the scale of the Covid-19 virus itself, as well as at the outermost planetary scale. If the discussion in this chapter is correct, then we are living within a chilling reminder of the real possibility of a “terminal species-specific” breakdown of our planetary-societies system. Furthermore, the time scale-factor mentioned earlier of possibly months for this global system may offer only a small window of opportunity for what may need to be a worldwide re-evaluation towards global cooperation to both mitigate climate change, as well as to control the Covid-19 pandemic.

The habit of complacency and not taking responsibility is unfortunately deeply entrenched, but a further warning sign might help to sharpen sensibilities. During the months when this book was being compiled, the Covid-19 virus developed a dangerous mutation which calls into question the

assumed limited ability of viruses to adapt to become more efficient self-evidencing organisms. The assumption of a very limited “temporal depth” in adaptive inference for simple biological organisms and for this particular virus may be a mistake we cannot afford to make, given that this dangerous mutation has emerged at little more than 6 months following the first serious outbreaks worldwide.

It may well be that the meaning of “global cooperation” may only become really understood by dealing with these two parallel crises as equal members worldwide of a global “family”, of rich diversity, but shared responsibilities.

REFERENCES

- Buddhaghosa (5th century). *The Path of Purification: Visuddhimagga*. Kandy, Sri Lanka: Buddhist Publication Society, 2011.
- Brahmāli (2007). Jhāna and lokuttara-jhāna. *Buddhist Studies Review*, 24(1): 75-90.
- Castiello, U., Becchio, C., Zoia, S. *et al.* (2010). Wired to be social: the ontology of human interaction. *PLoS One*, 5(10): e13199.
- Cousins, L.S. (1973). Buddhist jhāna: its nature and attainment according to Pāli sources. *Religion*, 3: 115-31.
- Cousins, L.S. (1981). The Paṭṭhāna and the development of the Theravādin Abhidhamma. *Journal of the Pali Text Society*, 9: 22-46.
- Crosby, K. (2000). Tantric Theravāda: a bibliographic essay on the writings of Françoise Bizot and others on the Yogāvacara tradition. *Contemporary Buddhism*, 1(2).
- Crosby, K. (2013). *Traditional Theravāda Meditation and its Modern-Era Suppression*. Hong Kong: Buddhist Dhamma Centre of Hong Kong.
- Dennison, P.A. (1997). Language and defence and the self-representation. Essay, Regent’s College School of Psychotherapy.
- Dennison, P.A. and Carson, J. (2008). The role of groupwork in tackling organisational burnout: two contrasting perspectives. *Groupwork*, 18(2): 8-25.
- Dennison, P.A. (2012). Psychodynamic staff support groups: avoiding burnout.
- Dennison, P.A. (2019). The human default consciousness and its disruption: insights from an EEG study of Buddhist jhāna meditation. *Frontiers in Human Neuroscience*, 13(178).
- Dennison, P.A. (2020). *The Seven Bojjhaṅgās: The Buddhist Factors of Enlightenment, the Jhānas and Days of the Week Buddha Images*. London: Itipiso Publications.
- Dimarco, K. (2013). Tavistock model infant observation in psychodynamic psychotherapy training. *Australasian Psychiatry*, 21(3).
- Dunning, D. *et al.* (2018). The effects of mindfulness-based interventions on cognition and mental health in children and adolescents: a meta-analysis of randomised controlled trials. *Journal of Child Psychology and Psychiatry*, 60(3):244-58.
- Freud, S. (1890). *Psychical (or Mental) Treatment*. The Standard Edition of the Complete Psychological Works of Sigmund Freud, Vol. VII.
- Freud, S. and Breuer, J. (1893). *On the Psychical Mechanism of Hysterical Phenomena: Preliminary Communication*. The Standard Edition of the Complete Psychological Works of Sigmund Freud, Vol. II.
- Freud, S. and Breuer, J. (1895). *Studies on Hysteria*. The Standard Edition of the Complete Psychological Works of Sigmund Freud, Vol. II.
- Freud, S. (1894). *The Neuro-Psychoses of Defence (an attempt at a psychological theory of acquired hysteria, or many phobias and obsessions and of certain hallucinatory psychoses)*. The Standard Edition of the Complete Psychological Works of Sigmund Freud, Vol. III.
- Freud, S. (1895 [1950]). *Project for a Scientific Psychology*. The Standard Edition of the Complete Psychological Works of Sigmund Freud, Vol. I. London: Hogarth Press.
- Freud, S. (1911). *Psychoanalytic Notes on an Autobiographical Account of a Case of Paranoia*. Penguin Freud Library Vol. 9 (London: Penguin).

- Freud, S. (1915). *General Psychological Theory: The Unconscious*. New York: Collier Books.
- Friston, K.J. (2010). The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience*, 11:127-39.
- Friston, K.J. and Buzsaki, G. (2016). The Functional Anatomy of Time: What and When in the Brain. *Trends in Cognitive Science*, 20(7): 500-11.
- Friston, K.J. (2018a). Am I self-conscious? (Or does self-organisation entail self-consciousness?). *Frontiers in Psychology*, 9(579): 1-10.
- Friston, K.J. (2018b). Active inference and cognitive consistency. *Psychological Inquiry*, 29(2): 67-73.
- Friston, K.J., Fagerholm, E.D., Zarghami, T.S., Parr, T. *et al.* (2020a). Parcels and particles: Markov blankets in the brain. *Network Neuroscience*.
- Friston, K.J., Wiese, W. and Hobson, J.A. (2020b). Sentience and the origins of consciousness: from Cartesian duality to Markovian monism. *Entropy*, 22(5): 516.
- Gethin, R. (1998). *Foundations of Buddhism*. Oxford: Oxford University Press.
- Grooms, J.K., Thompson, G., Pan, W.-J., Billings, J. *et al.* (2017). Infralow EEG and dynamic resting state network activity. *Brain Connectivity*, 7(5).
- Guevara Erra, R., Mateos, D.M., Wennberg, R. and Perez Velazquez, J.L. (2016). Statistical mechanics of consciousness: maximization of information content of network is associated with conscious awareness. *Physical Reviews E*, 94(5).
- Gunaratana, H. (1980). A critical analysis of the jhānas in Theravada Buddhist meditation. PhD dissertation. Washington: The American University. Published (1985) as *The Path of Serenity and Insight: An Explanation of Buddhist Jhānas*. Delhi: Motilal Banarsidass.
- Harvey, P. (2012) *An Introduction to Buddhism*. Cambridge: Cambridge University Press.
- Herbet, G., Lafargue, G., Menjot de Champfleury, N., Moritz-Gasser, S. *et al.* (2014). Disrupting posterior cingulate connectivity disconnects consciousness from the external environment. *Neuropsychologia*, 56, 239-44.
- Holmes, J. and Nolte, T. (2019) "Surprise" and the Bayesian brain: implications for psychotherapy theory and practice. *Frontiers in Psychology*, 10.
- Holmes, J. (2020). *The Brain has a Mind of its Own: Attachment, Neurobiology and the New Science of Psychotherapy*. London: Confer Books.
- Huang, S.-L., Li, R.-H., Huang, F.-Y. and Tang, F.-C. (2015) The potential for mindfulness-based intervention in workplace mental health promotion: results of a randomised controlled trial. *PLoS ONE* 10(9).
- Jung, C.G. (1912). *Psychology of the Unconscious*. Chelmsford, Mass.: Courier.
- Kanai, R., Komura, Y., Shipp, S. and Friston, K. (2015). Cerebral hierarchies: predictive processing, precision and the pulvinar. *Transactions Royal Society B*, 370: 20140169.
- Kirchhoff, M., Parr, T., Palacios, E., Friston, K. and Kiverstein, J. (2018). The Markov blankets of life: autonomy, active inference and the free energy principle. *Journal of the Royal Society Interface*.
- Klimesch, W. (2013). An algorithm for the frequency architecture of consciousness and brain body coupling. *Frontiers in Human Neuroscience*, 7(766).
- Kruglanski, A.W., Jasko, K., Milyavsky, M., Chernikova, M. *et al.* (2018). Cognitive consistency theory in social psychology: a paradigm reconsidered. *Psychological Inquiry*, 29(2): 45-59.
- Lancaster, B.L. (1997). On the stages of perception: towards a synthesis of cognitive neuroscience and the Buddhist Abhidhamma tradition. *Journal of Consciousness Studies*, 4(2): 122-42.
- Leibniz, G.W. (1707). *New Essays Concerning Human Understanding*. Trans. A.G. Langley (1896), New York: Macmillan.
- Leibniz, G.W. (1707). *New Essays on Human Understanding*. Ed., trans. P. Remnant and J. Bennett (1982), Cambridge: Cambridge University Press.
- Liu, Q. *et al.* (2020). Changing rapid weather variability increases influenza epidemic risk in a warming climate. *Environmental Research Letters*, 15: 044004.

- Lothane, Z. (1998). Freud's 1895 Project: from mind to brain and back again. *Annals New York Academy Sciences*, 843: 43-65.
- Lovelock, J.E. and Margulis, L. (1974). Atmospheric homeostasis by and for the biosphere: the Gaia hypothesis. *Tellus*, 26(1-2).
- Maldonato, N.M. (2014). "The ascending reticular activating system: the common root of consciousness and attention", in Recent Advances of Neural Network Models and Applications, *Proc. 23rd Workshop Italian Neural Networks Society*.
- Masson, J.M. (1985). *The Complete Letters of Sigmund Freud to Wilhelm Fliess 1887-1904*. Cambridge, Mass. and London: The Belknap Press.
- Merker, B.H. (2013). The efference cascade, consciousness, and the self: naturalizing the first person pivot of action control. *Frontiers in Psychology*, 4(501).
- Oseledchik, M., Ivleva, M. and Ivleva, V. (2017). The fractal nature of implicit knowledge. In *Advances in Social Science, Education and Humanities Research*, Vol. 144. 3rd International Conference on Arts, Design and Contemporary Education. Paris: Atlantis Press.
- Pascual-Marqui, R.D. (2002). Standardized low resolution brain electromagnetic tomography (sLORETA): technical details. *Methods and Findings in Experimental Clinical Pharmacology*, 24D, 5-12.
- Pearl, J. (1988). *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference*. San Mateo CA: Morgan Kaufmann.
- Petersen, S.E. and Posner, M.I. (2012). The attention system of the brain: 20 years after. *Annual Review Neuroscience*, 35, 73-89.
- Phillips, A. (2006). *The Penguin Freud Reader*. London: Penguin.
- Pounds, J.A. et al. (2006). Widespread amphibian extinctions from epidemic disease driven by global warming. *Nature* 439.
- Russell, B. (1900). *A Critical Exposition of the Philosophy of Leibniz*. Cambridge, UK: Cambridge University Press.
- Seth, A.K. and Friston, K.J. (2016). Active interoceptive inference and the emotional brain. *Philosophical Transactions of the Royal Society B* 371: 20160007.
- Simpson, I. (2010) Containing the uncontainable: a role for staff support groups. In *Psychological Groupwork with Acute Psychiatric Inpatients*. London: Whiting & Birch, pp. 87-105.
- Solms, M. and Panksepp, J. (2012). The "Id" knows more than the "Ego" admits: neuropsychanalytic and primal consciousness perspectives on the interface between affective and cognitive neuroscience. *Brain Sciences*, 2(2): 147-75.
- Solms, M. and Friston, K.J. (2018). How and why consciousness arises: some considerations from physics and physiology. *Journal of Consciousness Studies*, 25(5-6): 202-38.
- Solms, M. (2019). The hard problem of consciousness and the free energy principle. *Frontiers in Psychology*, 9:2714.
- Suppes, P. and Warren, H. (1975). On the generation and classification of defence mechanisms. *International Journal of Psychoanalysis*, 56: 405-14.
- Thorndycraft, B. and McCabe, J. (2008) The challenge of working with staff groups in the caring professions: the importance of the team development and reflective practice group, *British Journal of Psychotherapy*, 24(2): 167-83.
- Upatissa Thera (~5th century) *Path of Freedom: Vimuttimagga*. Maharagama, Sri Lanka: The Saman Press, 1961.
- Wallace, B.A. (1999). The Buddhist tradition of Samatha: methods for refining and examining consciousness. *Journal of Consciousness Studies*, 6(2-3): 175-87.
- Winnicott, D.W. (1953). Transitional objects and transitional phenomena - a study of the first not-me possession. *International Journal of Psychoanalysis*, 34: 89-97.
- Woody, J.M. and Phillips, J. (1995). Freud's "Project for a Scientific Psychology" after 100 years: the unconscious mind in the era of cognitive neuroscience. *Philosophy, Psychiatry and Psychology*, 2 (2): 123-34.

Wu, X., Lu, Y., Zhou, S., Chen, L. and Xu, B. (2016). Impact of climate change on human infectious diseases: empirical evidence and human adaptation. *Environment International*, 86: 14-23.

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