THE COVID-19 PANDEMIC AND CLIMATE CHANGE: A FRACTAL CRISIS[†]

This article is based on Dennison (2019), and on a forthcoming chapter “The Human Default Consciousness, Jhāna Consciousness and Gaia “Consciousness”, with Some Thoughts on the Covid-19 Pandemic”, to be published in *Perspectives on Consciousness* (ed., P. Dennison, 2021), New York: Nova Science.

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Introduction

In order to exist at all, all biological and living systems require to be distinguished from their environment by a boundary; but a very interesting type of boundary. On the one hand it must allow the internal states, or organism, or person, to be independent to a degree, yet to be able to act on information from the environment, and then to influence that same environment by its actions. Theory predicts that all such systems interact with each other across hierarchies, from the micro scale of the simplest organisms such as a single cell or virus, up through, for example, the development of a fertilised egg in the womb, the interaction of a baby with mother, an individual in society, societies to their encompassing countries, and at the highest level between societies worldwide and planet Earth. It is this highest level in the hierarchy we will eventually come to in this article, but first the background to these ideas.

Markov Blanket Hierarchies

Sensory Consciousness

The “boundary” mentioned above is termed a Markov blanket in statistical probabilistic theory, an evocative term coined by Judea Pearl, a computer scientist and philosopher, in 1988. Without such 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 as applied to neuroscience, initiated by Karl Friston of University College, London, from 2010. 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 1).

In this model of active inference, sensory inputs are received from the

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outer world (left), as well as from the body via the brain stem, then processed (right), leading to action choices based on prior experiences and their associated feeling-tones held in memory (Seth and Friston, 2016). The chosen action then feeds back to update the “priors”, and the cycle repeats with continuously updating inputs. This interactive model of a person’s engagement with their environment is a description of how our everyday sensory consciousness operates, and how these reciprocal interactions underpin our default consciousness experiences of “I am” and “I do”.

It is because these two modes of information transfer – *sensory* and *action* – are functionally quite different that conditional independence is maintained; states internal and external to the Markov blanket can only influence each other *indirectly*, and the Markov blanket is simply 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 the human everyday sensory consciousness, described in Dennison (2019).

The two modes of information transfer – sensory from outside to inside, and by actions from inside to outside – are referred to as “information geometries” in statistical theory, but they can equally be thought of as forms of “communication”. Readers may be surprised that I 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 this case ourselves.

Jhāna Consciousness

In Dennison (2019), it was described how Buddhist jhāna meditation that requires a meditator to temporarily disengage their personal “I” from sensory consciousness, results in profound changes in brain activity. Such disengagement means, in effect, stepping outside the active-inference networks that constitute the individual-societal Markov blanket structure described above.

In terms of EEG brain activity, the sensory and jhāna modes of consciousness are quite different in their frequency structures. That of jhāna is characterised by very slow rhythmic activity (infraslow waves) with frequencies 0.03-0.125 Hz, i.e. time-scales ~8-33 seconds, with the faster δ , θ , α and β frequency bands of normal sensory consciousness virtually absent in the deepest levels of jhāna. Also, whilst sensory consciousness is supported by widely distributed brain activity, with subject-object processes at least partially reflected in frontal-posterior interactions, during jhāna meditation activity becomes focussed at the crown of the head, as shown in the 3D and sagittal plots of Figure 2.

The crown of head area is highly connected down through core areas of the brain towards the

brain stem, and further into the vagus nerve systems of the body, reflecting a quite different vertical axis of jhāna consciousness as shown in the conceptual illustration of Figure 3.

The sensory and jhāna modes of consciousness differ very significantly in time- and spatial-scales. The time scale-factor of jhāna noted above, ~10-30 secs, is 100-300 times slower than the ~100 ms time scale-factor of our default sensory

consciousness (= the typical reaction time; i.e. the shortest time from stimulus/perception to action). And if we take an approximate figure $\sim\frac{1}{2}$ -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.

It is consistent with the much greater spatial scale, and much slower time scale-factor, that jhāna consciousness is experienced subjectively as an almost timeless “presence”, rather than the sensory consciousness experience of a continuous series of “this” or “that”, and more all-encompassing of the whole person: brain, body and mind (hence, “embodied presence”).

It follows from the above that the Markov blanket structure supporting jhāna consciousness is also radically different to that which supports sensory consciousness. Instead of information transfers between the brain and its sensory environment, the interaction for jhāna consciousness appears to be internal between the brain and the body, and the most likely explanation for the much slower time scale factor is that it is determined by much slower visceral interoceptive information transfer (“communication”) via the brain stem, rather than the much faster sensory information flows between the brain and its sensory environment.

Figure 3

Mother–Baby Markov Blankets

Whilst all this might seem rather abstract, all human beings have lived through a profound Markov blanket interaction with their mothers, and in that sense have visceral knowledge of these interactions. In the womb, the fertilised ovum contained within the boundary of the amniotic sac is held in a Markov blanket relationship with the outer environment of the mother’s womb. At a micro level, the developing foetus will itself be the container for many ensembles of subordinate Markov blanket structures representing the many developing systems for the baby’s brain and body; while at an enveloping macro level, the mother is in a Markov blanket relationship with her outer support system of family.

As a foetus develops, we might expect the information geometry or “communication” across the mother–foetus Markov blanket to be mostly via biochemical and interoceptive channels to maintain homeostasis, although ultrasound studies of twins during the later stages of pregnancy show clear evidence of purposeful (and sensory-based) inter-twin interactions (Castiello *et al.*, 2010).

The situation changes somewhat following birth, as direct sensory information transfers take over. However, in terms of active inference, the mother is still the dominant “environment” to the baby’s internal states. If interactions are sufficiently consistent and positive (what Winnicott, 1953, described as “good-enough” mothering), a baby will tend to develop a stable and pleasant sense of subjectivity; 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. As the baby realises that actions (e.g. crying; or smiling) elicit a response, this grammar is extended to subject-verb-object, and as the subtlety of early reciprocal relationships develops, conditionals and other elements of

grammar follow (Dennison, 1997). 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 development of language highlights also that language is a key feature, perhaps *the* key feature, of interactions within sensory consciousness.

“Communication” and Self-Similarity across Markov Blankets

Taking as a premise that bi-directional information transfers across hierarchies can be regarded as forms of communication, then for active inference to work, action choices of inner states based on sensory inputs from “outside” necessarily imply a *directedness* or *agency*. This raises the intriguing question as to what or who is the agent, and the nature of subjectivity and consciousness. Recent developments in neuroscience (e.g. Friston *et al.*, 2020a) highlight here the crucial role of “temporal depth” in active inference, which for the human–environment system is deep enough to allow actions to be chosen that consider (via very fast recursive unconscious processing) long-term consequences. This also implies awareness of a time-line linking past to present to future, and that together with an ever-present bodily system with continuous awareness (as *affect*) of interoceptive processes, that together these processes may be identified with as “I am” and “I do” in sensory consciousness.

In terms of “consciousness”, this principle allows a distinction to be made along a continuum from simple non-conscious systems such as single-cell organisms or viruses which have only a rudimentary and short-term reflexive information geometry across their Markov blankets, up to the far more extensive and complex information geometries for human active inference across their Markov blanket systems.

Whilst most Markov blanket research has focused on brain networks, the mathematics is transferable across different hierarchical scales, and should apply to all examples of “life”. Overall, theory predicts that:

- Moving up hierarchies, successively larger-scale and slower dynamics develop. So the time scale-factor for viruses at the micro scale is fast (and largely reflexive and immediate) compared to human beings with sensory time-scales, whereas the largest planetary–societies system will have a far slower time scale-factor than any lower hierarchies – we might guess at months or years, based on climate change processes.
- Each Markov blanket system will contain several, maybe many, subordinate systems, each of which in turn will contain subordinate systems, and so down the hierarchy. This has been demonstrated for the brain’s neuronal networks, with a hierarchy of scales from the entire brain, down through a range of subordinate systems to, finally, the smallest groups of neuronal processes that function as self-organising assemblies.
- Each level of a hierarchy in its interactions with subordinate (inner) and superordinate (outer) levels will lead to *self-similarity* between hierarchies. And for any particular Markov blanket system, internal states will tend to become *models of their environment* (Kirschhoff *et al.*, 2018).

Such self-similarity is easily recognised in the mother-baby Markov blanket system described above, where, given a “good enough” mother, reciprocal active-inference loops lead to an autopoietic self-similarity between mother and baby. This self-similarity can also be seen at larger social scales, where cities and countries develop patterns of behaviour, mannerisms and dialects of language unique to that macro group as characteristics of their self-similarity.

A Global (Gaia) Markov Blanket

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 4, which is a satellite view of planetary weather systems with subordinate levels of cities and peoples. It is tempting to refer to this as the *Gaia* Markov blanket, the term *Gaia* first coined in this context by Lovelock and Margulis in 1974.

Figure 4

At this outermost scale, what kind of information transfer or “communication” might characterise such a Markov blanket system? For our everyday sensory consciousness the information transfer and communication is predominantly *sensory*, and underpinned by language. For the special case of *jhāna* consciousness, it is *interoceptively*-determined between body and brain, and experienced as presence and open

awareness of feelings and form, not underpinned by language.

At the highest planetary level of hierarchy, the Markov blanket characteristics listed above suggest a very much larger spatial scale, at a very much slower time-scale as characteristics of information transfer; for the latter we might hazard a guess based on seasonal climate changes of ~months. In terms of information transfer, or information geometries, a likely area to explore for such large-scale and slow dynamics might be the symbolic level of patterns or themes, and in particular fractal processes whereby information and meaning is reproduced and reconfigured at different scales across Markov blankets (Oseledchik *et al.*, 2016). In nature there are many examples of how patterns become reproduced across sometimes widely separated scales, as in the Figure 5 example showing the well-known spiral pattern of a nautilus shell (in cross-section), alongside a near-identical spiral pattern of the “whirlpool” galaxy at the galactic scale.

In fact fractal modes may play a part at all levels of hierarchy, as suggested by Dennison (2019) for the brain’s electrical scaled network activity, and a fractal aspect to hierarchical correlation across scales has also been suggested by Friston *et al.*’s (2020b) theoretical models.

As regards the requirement of self-similarity, there is already a proven link between chaotic and increasingly destructive climate change processes at the outer planetary level, and destructive and damaging processes at the societal level that are undoubtedly related to climate change. 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, including outbreaks of malaria and cardio-pulmonary disease related to the 1997-98 and 2015-16 *El Ninos*. In addition, episodes of severe flooding at multiple sites worldwide have been related to outbreaks of cryptosporidium, typhoid, cholera, lymphatic disease and haemorrhagic fever; heatwaves have led to West Nile fever and increased morbidity and mortality from infectious respiratory diseases; and drought has led to hantavirus pulmonary syndrome (HPS), increased risk of West Nile virus and transmission of the St. Louis encephalitis virus.

In this case, a candidate for a theme for information transfer, or “communication” between outer and inner, or a fractal pattern of self-similarity, might be “disturbance” versus “non-disturbance”. Given such self-similar patterns, 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, and that these two potential disasters may be interrelated.

Breakdown of the Global Markov Blanket

The question of the stability of Markov blanket systems is related to the dynamics of *ensembles* of Markov blankets. In particular, a Markov blanket at a higher superordinate macroscale will contain 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 stability and minimisation of free energy. This is clearly the case for the brain's activity, where interactions with the sensory world have evolved over history into a remarkably stable and low-energy dynamic balance.

However, it is an open question as to the stability of the outer global–societal Markov blanket, particularly given the crises of the last year, 2020.

Theory describes that the risk of instability increases for systems with a large and complex array of subordinate Markov blanket structures, which is precisely the case where those “inner” structures include countries worldwide with widely disparate cultures and often conflicting agendas. 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” (*ibid.*, p. 8). The former would correspond to sensory consciousness and the brain's default activity, but it is the latter “self-assertive tendency” which we hypothesize as threatening to the stability of the “Gaia” Markov blanket system.

On a global scale, we have many examples of selfish and self-assertive behaviour: 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 even to their own peoples; and, in the context of this chapter, the refusal across countries to share responsibility and act together 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 chilling statement that “to remain alive an organism must avoid crossing terminal species-specific phase boundaries” (*ibid.*, p. 6).

A Fractal Crisis

It is rather ironic that the reason for the stability of our everyday sensory consciousness that supports our sense of identity, is that adaptive active inference processes have evolved over long periods of history to develop great temporal depth, that leads us to, mostly unconsciously, take into consideration the possible consequences of our actions well into the future in the choice of actions. Yet in the case of climate change there is still a reluctance, even denial on the part of some world leaders, to recognise the danger and to take decisive action.

Undoubtedly, a large part of the problem is unfamiliarity with how large-scale patterns become reproduced in comparison to more easily understood and short-term actions and consequences. Take, for example, the parallels in themes between climate change and the Covid-19 pandemic. On the one hand, over recent years, we have increasingly seen catastrophic out-of-control fires and flooding proven to be related to climate change and global warming, while in parallel societies are 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, is unfamiliar, particular to those used to more direct correspondences in language. Yet a psychiatrist or psychoanalyst might be reminded of distorted (tangential) speech in schizophrenia, a result of disengagement from reality similar to Freud's (1924) description of how words become “things” (or in this case “themes”) 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, as suggested earlier, 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 across countries, and a stable climate, while breakdown of the Markov blanket system would be characterised by self-similar disturbances of both the outer and inner systems, as we are currently witnessing.

Disturbance and Pathology is Contagious across Hierarchies

For those readers who find these fractal or theme-based forms of self-similarity difficult to understand, here is an example of how self-similarity can become destructive or even toxic in some situations, rather than benign as in many well-functioning systems such as supportive families and (good-enough) mothers and babies. The example is 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 caseloads 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 – e.g. splitting, projection, paranoia, denial among other

symptoms. 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, even the “leader” (maybe similar to some current world leaders), acting-out the madness that cannot be acknowledged or moderated by others in the team.

And at the same time, it is not uncommon that at the superordinate level managers might become punitive and highly critical, or lapse into denial, losing empathy with their teams. 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; 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 may already be in a process of breakdown, evidenced by catastrophic climate change at the planetary level, and increases in pathogens, including the Covid-19 virus, at the societal level. Yet the evidence from lesser catastrophes in the past is that those who could take action do not readily take responsibility to moderate or change destructive 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, as in Figure 1. 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 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 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 neighbours via global competition, no matter the cost.

Conclusion

It was mentioned early in this article that a determining factor in action choices is what they mean, or feel like, for the subject. That is, liking or disliking, wanting or not-wanting – or more bluntly greed versus aversion, or even hatred. This also corresponds to psychoanalytic and Buddhist understandings of psychopathology and human suffering. In the case of psychoanalysis (starting from Freud, 1894), the approach is to uncover processes of denial and defence rooted in fear or craving for satisfaction, effectively to make the unconscious conscious; processes also described by Holmes and Nolte (2019) as highly relevant to the more recent free-energy and active inference literature. And in Buddhism, the cause of human suffering is located in craving, in particular greed or ill-will inherent in attachment to a sensory world (Harvey, 2012); hence the value of *jhāna* meditation in giving at least a temporary experience of freedom from that attachment. It is precisely these distortions based on greed or aversion that can lead to destructive action choices that can undermine active inference processes, and stability of Markov blanket systems.

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 seen in its effectiveness 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. 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, and the existential shock of the Covid-19 pandemic may provide a small window of opportunity.

Furthermore, given the discussion above on Markov blanket interactions, for societies worldwide to relate consistently and stably to the outer planetary level, to be able to “make inferences about the outcomes of [their] own actions” (Kirschhoff *et al.*, 2018.), then they are *implicitly* required to function as a united agency. If the arguments in this article are correct, then we are living within a chilling reminder of the real possibility of a “terminal species-specific” breakdown of our planetary-societies system, and that the window of opportunity to take a new direction towards global cooperation, to mitigate climate change and prevent future catastrophes such as the Covid-19 pandemic, may be measured in months rather than years.

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, and the factors that determine stability or instability are common across all levels. It may be that the meaning of “global cooperation” might 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.

A further warning sign might help to sharpen sensibilities. At the time of writing this article, 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, and, intriguingly, at a point where we are only barely in a position to combat the threat by newly developed vaccines.

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