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Remembrance of things to come: a conversation between Zen and neuroscience on the predictive nature of the mind

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Abstract The notion of the brain as a predictive organ following Bayesian principles has been steadily gaining favor in neuroscience. This perspective, which has broad theoretical and applicative consequences, suggests also a novel way to look at the mind-body processes mobilized by meditative practices. In this article, the topic is introduced and subsequently explored as a conversation between a neuroscientist (GP) and the abbot of a Zen Sōtō monastery (FTG). We believe that such ‘mutual perturbations’ between the third-person descriptions provided by scientific research and the phenomenological depth of Buddhist lore have a great potential for advancing our understanding of both brain function and meditation.

Keywords Predictive coding · Meditation · Bayes · Free energy · Autopoiesis · Neurophenomenology · Zen · Zazen

Introduction

In his proposal of neurophenomenology as a research manifesto, Francisco Varela argued for the need of a profound collaboration between the third-person descriptions of brain function provided by neuroscience

and the first-person insights about mental phenomena gained by the disciplined practice of contemplative techniques (Lutz & Thompson, 2003; Varela, 1996; Varela, Thompson, & Rosch, 1991). While the number of studies on the cognitive and neural effects associated with meditation has shown an impressive growth in the last decade, the neurophenomenological programme has not flourished as fast as initially hoped. A potential factor lies in the lack of a theory of brain function that is general enough, yet enough articulated, to provide a plausible interpretative framework for both the neural and the mental domain. A promising candidate in this sense is the recent formulation by Friston (2010) of the minimization of free-energy as a unifying explicatory principle for a strikingly large variety of neural, cognitive, and biological processes. In the following, the main features and implications of this theory are illustrated and discussed as an informal dialogue between a neuroscientist (GP) and the abbot of a Zen Sōtō monastery (FTG).

GP I will start this conversation by providing a brief introduction to the subject matter of predictive coding: the idea that the brain operates essentially as a predictive device, constantly anticipating the upcoming sensory data with specific expectations that are then tested against the actual sensory evidence. In this theory, the extraordinarily rich connectivity structure of the brain allows it to encode in its synaptic networks a highly complex and hierarchical representation of the statistical properties of the environment: an *internal model* of the latter, in fact. Such internal model makes the brain an organ exquisitely specialized for performing inferential processes about the causes of sensory data, in keeping with Bayesian principles and along the fol-

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lowing iterative sequence: (i) *a priori* hypotheses about the hidden causes of sensory input are selected within the internal model (ii) these hypotheses generate expectations about the upcoming sensory signal (iii) the expected sensory data are compared to the actual sensory data; and (iv) the discrepancy between the two, or prediction error, is propagated upstream the neural hierarchy to induce a revision of the internal model in order to provide better predictions in the future.

While this may seem an abstract and overly mentalistic perspective, it is, quite to the contrary, a theoretical framework much in agreement with the crucial issues of situatedness and embodiment of cognition so important in modern cognitive science. More specifically, predictive coding — especially in its most general formulation of the ‘principle of free energy’ proposed by Friston (2010) — appears to provide a neurobiologically plausible and mathematically tractable update on many of the ideas entailed by Maturana and Varela (1980)’s theory of autopoiesis.

In the theory of autopoiesis, living systems are characterized by the capacity to resist disorder, that is, to conserve their form and function, in the face of a constantly changing environment. In the free-energy scheme, they do so by behaving in a way that minimizes the average surprise of sensations in the long term, under a model of the world they embody. For example, being out of water is an extremely ‘surprising’ state for a fish, a state that the fish will understandably go to great lengths to avoid (Friston, 2010). Note that, since surprise is conditional on the organism’s model of its world, the biological mandate to minimize average surprise does not compel the organism to seek out a dark cave to be shielded from any sensory stimulation — unless, that is, the organism is a troglophile specifically evolved for this type of environment (Friston, Thornton, & Clark, 2012).

While an organism cannot minimize surprise directly (this would require an exhaustive representation of the state of affairs in the world and the evaluation of an infinite number of behavioral trajectories), it can minimize *free energy*, an informational quantity that is always greater than surprise, thus leading to the effective avoidance of surprising states. Free energy can be evaluated by the organism because it depends only on the state and parameters of the internal model — encoding hypotheses about the causes of sensory data — and on the sensory data themselves. Crucially, under reasonable assumptions, free energy can be approximated by prediction error, and therefore free-energy minimization amounts to curb prediction error. This is a process of Bayesian inference: the sensory data are used to adjust the *a priori* beliefs about the state of the world (beliefs

held before observing the sensory data), to obtain better *a posteriori* beliefs (beliefs held after observing the sensory data).

A misty state of affairs

GP Having established our playing field, I would like now to open up the topic for discussion. A moment ago you read to me a sentence from your forthcoming book: “We should adopt the empirical assumption that nobody can really be convinced by anybody, and that, in particular conditions of discomfort, urgency and tension, the main resource is prejudice and no rational reason”. This statement — purposefully provocative, I believe — does highlight the relevance of *a priori* expectations (or prejudices) for our cognition and behavior. I feel that most of us hold a prejudice against prejudice, particularly in meditation-related circles: we tend to think that it is wrong *a priori* to be guided by our preconceived notions, that we should always base our important decisions on ‘real facts’ and strive to perceive reality ‘as it is’.

The predictive coding framework offers a refreshing perspective on this issue. When the sensory signal from the outside world is noisy, ambiguous or unreliable, it makes perfect sense for decisions to be based on the internal, off-line, *a priori* model of the world. Imagine to find yourself lost in a thick fog on your way back home (the wonderfully oneiric scene of Titta’s grandfather in Fellini’s movie ‘Amarcord’ comes to mind here): you will have a much better chance of reaching your destination safely by relying more on your ‘preconceived’ mental map of the landscape than on the ‘real’ visual input (which can nonetheless provide a measure of verification).

I guess I am striking a familiar chord here, given that one of your books is titled ‘Facts of Mist’ (Guareschi, 2013), an ambiguous title in itself (in Italian, ‘Fatti di Nebbia’, may be equally interpreted as ‘Facts of Mist’, ‘Made of Mist’, or ‘High on Mist’). The ‘mist’ is seen not as an unfortunate condition but as a precious, poetic opportunity to make your *a priori* light up, activate.

FTG In a sense, we can only seek what we already know; but what we know is given to us through ways that are somehow misty, mysterious, not clearly accessible by consciousness. Intuition is another way of talking about this. I follow my nose, then I take my bearings, but I fundamentally keep following my nose; the ‘nose’, however, is very long, subtle, unspeakably prophetic.

The idea of a higher-order *a priori* guiding our behavior that is at once also rooted in the primeval, core

features of our being, is no stranger in religion. My teacher, Deshimaru Taisen, used to say provocatively that the true man conforms to the archetype of the man-puppet, who is being *led* by the Dharma or, I would say, by the prophetic dimension.

GP By the way, in his posthumously released series of interviews “L’Abécédaire”, Gilles Deleuze quipped that Zen is ‘nez’ (‘nose’, in French) read backwards! If I am following your thought correctly, prophecy can be taken as an intuition that never manifests itself in ‘high-definition’, but has nonetheless a tremendous causal power; a priori structures that guide us without us being able to identify them precisely, to nail them down conceptually.

The archetype of the puppet is so interesting too, especially for its symbolic treatment of the issues of willed agency and self. Are we less ourselves when we surrender to a guiding power that we feel transcends the purview of our will? In Japan, the *bunraku* marionette is considered to be the perfect actor because it is unencumbered by the human ego; to reach the peak of its art, an actor should in fact aspire to become a puppet. In Italy, Carmelo Bene uncannily embodied this notion in his performance practice as an ‘actorial machine’ (Bene & Deleuze, 2002), perhaps nowhere more literally than in his own version of Pinocchio. Interestingly, in Colodi’s novel the all-important alchemic transmutation of a piece of inert wood into living flesh is operated through Pinocchio constantly taking the *wrong way*, a behavior that seems to carry the stamp of necessity for the character’s evolution. In a sense, the mistakes that Pinocchio-the-puppet makes are not truly his but, precisely because of his innocent, complete abandon to the invisible strings that move him about, are indeed truly transformative.

FTG The idea that discrepancies and accommodations represent the weft and warp of life’s fabric is quite convincing to me. In fact, committing errors seems also the way by which communication between people actually proceeds: the road of mutual comprehension is truly paved with misunderstandings, in the sense that the surprise I feel when I realize that my thought about you was off the mark, and viceversa, is a powerful factor in developing our relationship. I like to view this as a process of ‘creative schismogenesis’, borrowing Gregory Bateson’s notion of an action that generates forces or tendencies of opposing polarities. The crucial point is that your expectations are *never* fully met.

GP They are always met, that is, with a discrepancy, a prediction error whose accommodation is the essence of

cognitive activity. Errors, thus, as integral to the way cognition works.

I think that an important point for what concerns our discussion is that in this theory there is really no place for the view that we can eventually — perhaps through meditation — come to perceive reality as ‘it really is’, if this is taken naïvely to mean a reality ‘out there’ that is independent of our concepts and prejudices. Can realization possibly mean to become deeply *aware* of the intrinsic entanglement between truth and prejudice? It strikes me how close this seems to be to the thought of Dōgen Zenji, the patriarch of the Zen Sōtō in Japan. I am thinking particularly about the *Kūge* (‘Flowers of Emptiness’) fascicle in the *Shōbōgenzō*, where we read, in the beautiful translation of Kim (2007):

Never foolishly misconstrue dim-sightedness as falsehood and thereby look for truth outside it. That is a short-sighted view.

Because enlightenment is rooted in dim-sightedness, all things that constitute enlightenment are invariably the ones adorned with the dim-sightedness.

Because delusion is also rooted in dim-sightedness, all things that constitute delusion are invariably adorned with the dim-sightedness as well.

FTG It is a crucial point. In movies, we often see a cop or a villain shooting at a door lock to force it open. Obviously the director knows that this is not what happens in real life — you will get seriously wounded or killed by the ricocheting shrapnels — but nonetheless chooses to stage the scene the *wrong way* to make it vividly representable in the required time frame (knocking a door down is much more difficult and time consuming than we think). The fact that it is often necessary to use a ‘mistake’ to maintain a narrative rhythm, however, should make us question the conventional meaning and import of errors.

GP A narrative that develops exactly as expected ceases to be engaging pretty soon, each event being explained away, and thus quickly disposed of, by our predictions. On the contrary, when something violates our expectations, it becomes featured in our consciousness with a characteristic saliency, a phenomenon that can be skillfully deployed by artists to create a vital pulse in their work.

FTG The ‘error’, if we still want to call it such, touches on, stirs something that comes before it, which is the structure of the a priori, the Kantian transcendental in a sense. Meditation itself operates within this regressive

motion. Deshimaru Rōshi was fond of using the sentence “to come back to the original state of the body and mind: this is satōri”. But to return to our cinematic example, you are almost compelled to not speak the truth in order to express it effectively: in a sense, it is the truth itself that demands it. Schismogenesis here entails that what appears as a mistake generates meaning, the incongruent piece of information is precisely what leaves a mark.

GP Which fits very well with the predictive coding scheme: the part of the signal that is predicted is suppressed, ‘explained away’; it is only the unexplained bit, the discrepancy, that propagates through the neural hierarchy to ultimately induce a modification of the mental landscape. This reminds me also of the linguistic device called *kireji* in Japanese traditional *haiku* poetry: literally a ‘breaking word’, which elicits a disturbance in the flow of the previous verse by cutting the forward arc of anticipation short. Such rupture is deemed to enhance greatly the poetic quality of the composition.

FTG The meaning has to be somewhat betrayed to make a lasting impression on the listener. It is not a simple matter of stage tricks or of pedagogic skillful means: I think this is really a basic feature of how our body-mind works. From a religious point of view, it has been said that it was *necessary* to have a Judas in the picture for the soteriological message of Christ to be fully realized. And, of course, the foundational salvific event itself in every religion, the pivotal point from which all soteriological meaning develops, is a great perturbation. In the hagiography of the Buddha’s life, the Earth literally trembled at each momentous turn point: at Shakyamuni’s birth, when he attained *nirvāna*, when he entered the *parinirvāna*.

Mind-body: a non-dualistic autopoietic process

GP Going back to the biological level, I think that Varela’s generalization of the concept of cognitive activity as the process of accommodating perturbations by an autopoietic system was really a seminal idea. It frames the mental sphere within the biological imperative of maintaining homeostasis, of keeping the entropy of the system’s internal states low to avoid dissolution of its structure and function. This notion is at the core of the free-energy principle as well, which states that “any self-organizing system that is at equilibrium with its environment must minimize its free energy” (Friston, 2010) or, in simpler words, must minimize the probability of

incurring into surprising states in the long term. ‘Surprising’ is obviously conditional on the organism’s expectations, which are generated by an internal model of the world.

Now, three aspects of the free-energy model are crucial: first, the model is highly hierarchical and it is thus able to emulate the multi-layer structure of the world’s causal dependencies; second, while the predictions issued by the model are ‘a priori’ with respect to the contingent sensory signals (ie, a priori in a synchronic sense), the model itself has formed through a developmental and phylogenetical history of interaction with the environment and is thus (in a diachronic sense) the sedimentation of ‘a posteriori’ information; lastly, since the causal web of interactions experienced by the organism has come effectively to be mirrored by, or embodied in, the organism’s structure/function, it is appropriate to say that the organism *is*, rather than has, a model of the world. In this sense, the organism’s tendency to minimize surprise by striving to confirm its internal model’s predictions is equivalent to a constant drive to confirm its own identity.

In this context, the brain does have a privileged role because its neural cells, in virtue of their capacity to implement complex hierarchical networks of fast signal transmission, are perfectly suited to mirror the world’s multi-layered concatenation of causal relationships (or, more precisely, the subset of the causal relationships that are relevant for the organism, and thus define the organism’s *lived* world). However, similar processes of autopoiesis or prediction-error minimization occur everywhere within the organism at several different levels, and the organism itself behaves as a whole in its environment to minimize surprise. The entwinement of mind, brain, body and environment is very evident in this picture.

FTG Deshimaru Rōshi used to say that *zazen* (the seated meditation practiced in Zen) is not *zazen* if it does not involve the interaction of psyche, soma, and environment. Not a body and a mind in an environment, but an environment that is part of body and mind. As noted by Kim (2004), Dōgen was very keen on using the word ‘body-mind’ (Jap. *shinjin*), as in the expression “mustering the body-mind” (Jap. *shinjin o koshite*) indicating the totality of effort required to understand oneself and the world. While a mindful, disciplined attitude towards the body underlies Buddhist training in general, being mindful of the body (Jap. *kan shin*), in Dōgen becomes the body being mindful (Jap. *shin kan*). I would say that this shift of accent reflects the intuition that the acting body is somewhat primal to cognition: in nature, the body is constantly exposed to

threats and it needs necessarily to be endowed with an elemental faculty of vigilance, which comes before and is quicker than thought as conventionally understood.

GP The body-mind is constantly exposed to perturbations that, on the other hand, represent as many opportunities for the autopoietic process, for re-creation.

FTG Yes, I would say that an organism is more of an ‘organism’ the further it is able to venture risking its own disorganization: its ‘organicity’ is proportionally enriched as the gamut of perturbations it is able to accommodate expands; and along this trajectory of increasing autopoietic bravura, surprise itself becomes more and more refined.

Perceptual and active inference

GP An aspect of the free-energy minimization theory that we haven’t discussed yet concerns the way by which an organism minimizes prediction error. There are two possibilities: a change in the state or parameters of the internal model on the basis of prediction error — so that the next prediction will be more accurate — or the active pursuit of the stimuli that will align more fittingly to the prediction, a trajectory leading again towards a minimal prediction error. For simplicity, we could refer to these two modalities with the verb ‘revise’ or ‘confirm’, respectively.

The ‘revise’ modality is what underlies the processes of both perception and learning. When the energy from an object hits our sensory surfaces, alternative hypotheses about the causes of the sensory stimulus are continuously tested by the internal model, until a stable minimum for the discrepancy between predicted and actual sensory signal is reached: only at this stage we recognize the object, with recognition being thus the product of a process of ‘perceptual inference’. During perceptual inference, the internal model changes its state of activity very quickly, on a time scale of milliseconds, as it settles on the best-matching hypothesis. Learning involves a change in the internal model as well, of its parameters in this case (strength of neural connections), rather than of its state of activity, something for which a longer time frame of minutes to days is required. Finally, phylogenetic selection itself could be seen as a process of free-energy (*free-fitness*) minimization that occurs over evolutionary time scales and produces changes in the whole structure of the organism.

The ‘confirm’ modality, on the other hand, is a process of *active inference* where the initial hypothesis generated by the internal model about the cause of sensory

input is kept temporarily unchanged, and the organism actively reorients its sensory surfaces seeking a stimulation that will best match the predicted one. More specifically, overt action is seen as the unfolding trajectory of a system attempting to minimize the discrepancy between expected and actual proprioceptive signals, with changes occurring on the same time scale as perception.

Now, our behavior and cognition seems to be based on the alternation between perceptual and active inference. In situations where the sensory signal is deemed reliable, perceptual inference prevails and the state of activity of our internal model adapts to accommodate prediction error. When the sensory signal is expected to be unreliable, however (as in our previous example of finding our way through a foggy night), active inference takes the lead and we are then mostly following our predictions (our ‘nose’), looking out and aiming for the sweet spot in the environment that will confirm them.

Attention and posture

GP In the free-energy scheme, the switch between perceptual and active inference is governed by attention, which increases the precision of specific prediction-error signals by raising the synaptic gain of the relevant neural cells. When a prediction error is expected to have a high precision, and thus to be trustworthy, it gets amplified and will therefore carry a large weight in changing the internal model. The expectation of a noisy (low-precision) prediction error, on the other hand, biases the system to rely more on its a priori information to decide the course of action.

I feel that this theoretical framework can be helpful to understand the processes activated by sitting meditation. In *zazen*, there seems to be an enhanced attention towards the posture, which is to be maintained in the face of thoughts and general mental content that may spontaneously arise. The specific attention to the posture may correspond to a recalibration of the respective weights assigned to the lower-level ‘sensory’ information streams and to the cognitive, autobiographically-based ‘a priori’ channels, in temporary favor of the former for the duration of the sitting. In our everyday life, we may have grown accustomed to a sizeable degree of distraction with respect to the actual sensory (exteroceptive, proprioceptive and interoceptive) signals and, consequently, to be quite unconsciously driven on by our personal endowment of beliefs and expectations, with little heed paid to what the world or our own body is telling us. While the influence of a higher-order a priori motif, such as a broad narrative of religious, archetypal or scientific nature, may constitute a powerful motivating force in our life (the strings holding the marionette

seem then to be manouvered with a distinctive aesthetic quality), beliefs and habits of a more mundane character, when rigidified and unverified, often represent impediments to development and realization.

Furthermore, the active, vigilant immobility of *zazen* seems to make the reservoir of the a priori expectations light up, become more transparent to consciousness, precisely in virtue of the fact that we *do not* follow them through with actions or other thoughts. Phenomenologically, the situation can perhaps be likened to the rarified intensity of Japanese Nō theater, where a prolonged stillness makes the appearance of a subtle gesture extremely salient. By maintaining the posture, we seem to set up a gap between expectation and its confirmation, an act that not only makes the cycle of expectation and confirmation-seeking itself more transparent to the meditator, but that also attenuates with time its reductive tension (the tension to reduce the gap). More specifically, the role of active inference, which strives to select a winning hypothesis by literally picking and choosing from the sensorium, appears abated during meditation. This could correspond to a flattening of the probability distribution over many priors encoding for different hypotheses, which may in turn facilitate mental flexibility and creativity by weakening the dominance of long held beliefs in favor of less-frequently considered alternatives.

FTG Deshimaru's formulation was "subjectivity becomes objective", meaning that during *zazen* there is an objective observation of subjectivity, a seemingly contradictory statement; this can in fact occur because the body takes the lead. In other words, the meditative posture, in its archetypal ritual essence, allows the experience of such a refined subjectivity that it ceases to be just subjective. The appearance of mental material during *zazen* is described as the uncovering of the 'storehouse consciousness' (Sanskrit, *ālaya vijñāna*), a deposit of karmic seeds (Sanskrit, *bīja*) from previous actions that condition our behavior and perception. I think this picture is not too dissimilar from the one you were presenting in terms of predictive coding. But how are we to deal with this karmic material during meditation? In our tradition, the various postural tensions, equilibria, their overall structure are considered crucial, you need a certain energy to be able to 'sit on your karma'. A vigorous posture *creates* a suitable space for this. We normally think about the posture as occurring *in* a place, but the posture in fact also *creates* a place. Space, as we conceive it, depends on our motor capabilities: I can assess quite precisely the distance that separates us right now because I have previously

walked across a similar distance, I have previously sampled it with my arm and hand.

GP There is indeed fairly convincing evidence from the cognitive sciences that even very basic conceptual categories such as time and space inherit their features from our capacity to move across the environment. For example, the abstract concept of a goal is naturally understood as a destination at the end of a path — that is, in terms of a very empirical movement-across-space — and this metaphorical process seems to be all but pervasive in our mental life (Johnson, 1987; Lakoff & Johnson, 1980).

FTG Space is created when a pre-reflexive body moves about in search of something — or is moved about *by* its search for something. This body that creates space is not the body that we can conceptualize, though: it is the body *before* any conceptualization. In Buddhist phenomenology, ignorance comes first, followed by action, and lastly by consciousness. Therefore, we neither *have* a body, nor *are* a body: both auxiliary verbs appear late in the process. And I suppose that, during *zazen*, the constantly reactivated posture repeatedly recreates that elemental space that is the fundamental context of any cognitive activity. We are talking of a very intense *zazen* here, something that is a bit rare these days.

GP These ideas are very similar to Merleau-Ponty's notion of the intentional arc binding the body to the world. It is the experience of the purposeful movement of the body that 'creates' the organism's lived world. Going back to *zazen*, we could perhaps say that if the posture is not activated to a certain degree during meditation (a process that necessarily involves attentional mechanisms), the intentional arc will be insufficiently taut for a vivid creation of the lived world. It seems as if the regulation of the posture facilitates the mind-body attuning that optimally positions us to interrogate/listen to the world; furthermore, in the case of *zazen*, it is the transcendental (in a Kantian sense) interrogating/listening attitude itself that is activated, rather than any specific hypothesis to be tested via overt action. Since this innate *disposition* (positioning) towards the world is, I believe, constitutive of our identity, proprioception may be actually more important for generating the feeling of Self than interoception, the perception of the physiological state of the body. And by regulating the posture we may thus gain some phenomenological insight into the very nature of the Self.

FTG When learning a traditional craft, one of the first tasks assigned to the apprentice is to clean up the workspace with a broom. This is very useful because the apprentice, while cleaning up, learns about the specific place where each tool is kept: you understand by cleaning up, because cleaning up activates that ‘sniffing’, interrogating/listening attitude and opens up the senses to the perturbations, to the unpredicted. But you need to throw yourself into the task with a certain vigor, just like in *zazen*.

In fact, I don’t think *zazen* really works without a great effort. It is not a merely individual effort either: the suitable postural tone is aided above all by a strong collective interaction and by the use of instruments such as the *kyōsaku* (the flat wooden stick sometimes employed during intensive *zazen* sessions to strike the muscular tissue between the shoulder and the neck, to remedy sleepiness or agitation), or the sound of the bells that interrupt mental processes and call to mindfulness. Otherwise, it is only a ‘monkey business’, as Maezumi Taizan Rōshi used to say: you believe you are ‘just sitting’ (Jap. *shikantaza*), when you are in fact jumping mindlessly from one thought to the other. This is why the *kōan* was invented, to give the wandering mind a kind of checkmate.

GP Zen being associated with great effort may sound odd to many a reader. In the early Chinese thinkers, from Confucius to Mencius to Zhuangzi, the ethical ideal was associated with the concept of ‘effortless action’ (Chinese, *wu-wei*), a way of behaving patently in accord with Heaven’s mandate and characterized by natural ease and ‘charismatic power’ (Chinese, *de*) (Slingerland, 2003, 2014). Zen, as the offspring of Chinese Chan Buddhism, has probably been influenced by these ideas and indeed it seems like we have stumbled across one of those paradoxical situations that the hagiography of Zen is rife with: a great effort that is actually a natural state, a lucid, vigilant attitude that is also somehow not consciously willed.

FTG The effort I am talking about (Jap. *shōjin*) should not be confused with a brute-force approach. It corresponds to the Sanskrit *vīrya* (the etymological root of ‘vigor’), a quality of sincere energy or intent that should accompany every element of the Noble Eightfold Path, and which is not incompatible with an attitude of fully entrusting oneself to the *Dharma*; it can take the form, for example, of a moral intensity in pursuing moderation. When *zazen* has this intensity, Dōgen said, ‘body and mind (are) cast off’ (Jap. *shin jin datsuraku*); Deshimaru Rōshi used the terms ‘metamorphosis’ or

‘transfiguration’, which are more familiar to the Greek-Latin cultural area. While teaching in France, he often used the phrase “*inconsciemment, naturellement, automatiquement*” (unconsciously, naturally, automatically) referring to the mind-body state in *zazen*, suggesting it was something with deep roots in our ancestral nature.

In a sense, you could say effort is a natural by-product of a calling, of being enamoured by a great story. Have you noticed how children immediately stop talking and moving, when told an engrossing tale? True stillness and internal silence in *zazen* are not a matter of coercion: they arise on the background of a vast narrative of religious nature, and we are able to truly sit only if this narrative has somehow called us personally. Caravaggio’s painting ‘The Calling of Saint Matthew’, portrays very cogently the power of Christ’s summoning gesture, which instantly turns the until-then reluctant Matthew into a follower.

GP And it is in Matthew’s Gospel, of course, that we hear Jesus saying “unless you turn and become like children, you will not enter the kingdom of heaven”. Now, the notion that during *zazen* it is the primal experience of the pre-reflexive body — a necessary prerequisite of any subsequent conceptualization — that is somewhat enhanced, is in agreement with the hypothesis that meditation involve a reduced activity of the prefrontal regions of the cerebral cortex, regions that are phylogenetically recent and particularly developed in humans.

More specifically, the lateral prefrontal cortex is especially active during cognitive control and executive function (Banich, 2009; Braver, 2012; Stout, 2010), that is, “when behavior must be guided by internal states or intentions” (Miller & Cohen, 2001), and when we voluntarily pick and choose. A reduced engagement of the lateral prefrontal cortex during demanding tasks is a feature of the child’s mind (German & Defeyter, 2000) and has been linked to greater cognitive flexibility (Limb & Braun, 2008), a psychological trait sometimes exhibited by patients who suffered a lesion in this area (Thompson-Schill, Ramscar, & Chrysikou, 2009).

Notably, meditation has been proposed to engender a ‘transient hypofrontality’ (Dietrich, 2003), facilitating a greater freedom from established categories — enhancing flexibility and creativity (see Colzato, Ozturk, and Hommel 2012) — and also leading to a decreased feeling of effort and conscious control (Cahn & Polich, 2006). If the a priori expectations governing our habitual patterns of thought and behavior are encoded primarily in the lateral prefrontal cortex, it is possible that during *zazen* the amplification of proprioceptive

signal associated with attending to the posture stalls these a priori habits in their anticipatory leap by decreasing their relative weight.

Now, what about breathing in *zazen*? Breathing is probably the most common attentional object across meditative techniques, but it seems to me that within the Sōtō school it takes a second seat, pardon the pun, to posture. In the theoretical framework we have been discussing, attending to the breathing may similarly entail an increased precision of sensory — interoceptive, in this case, rather than proprioceptive — signals, as attending to the posture. However, it seems to me that focusing too intensely on the breathing can sometimes produce a hypnagogic effect, due to its rhythmicity, and may also allow an excessively introspective attitude. Paying attention to the posture, on the other hand, seems to invite a more open and ‘situated’ presence, to which external and internal streams of information contribute in a balanced way.

FTG Breathing is indeed of fundamental importance in *zazen*: so much so, I would say, that it is often best to let well enough alone! While some Zen schools or teachers do employ an explicit attentional focus on the breathing, especially during the initial training stage (e.g. counting the breaths), and some teachers even prescribe a specific method of breathing regulation (typically, emphasizing the exhalation phase of the breathing, so to make it deep and prolonged), breathing as an intentional object tends more commonly to recede into the background as practice progresses. Nowadays, most teachers do not instruct on specific breathing techniques, but advise the students to just let the breath unfold naturally: this is likely because of the health risks involved in tampering with such a fundamental physiological process if the techniques are not performed with utmost care and commitment under the close supervision of the teacher. In fact, in the Sōtō tradition, specific instructions about breathing are typically found in the esoteric, orally transmitted teachings (Jap. *kirigami*), which are supposed to be exposed only personally from master to disciple when conditions are deemed suitable.

However, we should never lose sight of the essential non-instrumentality of *zazen*. Any form of instrumentality, in fact, detracts from the authenticity of what we call *zazen shikantaza*, an aspect alluded to by the presence of a variety of apophatic expressions in Zen, such as *mushotoku* (‘no gain’), *hi-shiryō* (‘nonthinking’), *shinjin datsuraku* (‘body-mind cast off’), in addition to *shikantaza* itself. Although the initial stages of the practice are often characterized by an instrumental overtone, beyond a certain point, both breathing and posture lose any expedient quality.

In a similar vein, it is also important to remark that the posture is never something that can be ‘owned’ personally, exclusively. What we call the practice of meditation is in fact the posture of the community, i.e. of the relationship, precise and diffuse at the same time, between each member of the community. Within Buddhism, the Three Treasures is not merely a slogan: Buddha, Dharma, Sangha are really inseparable. This relational nature of the posture is not even limited to conspecifics: you could say that the meditative posture is also, for instance, the posture of the gardens (Zen and otherwise). In summary, the posture of *zazen* is not merely an exercise concerned with refining the psychophysiological processes of a mind-body, but harks back to a constitutive dimension of human nature that includes a constant soaring towards a symbolic reality, through mythopoietic visions and cultural activities.

Time perception

GP The brain appears to be constantly busy. A large body of neuroimaging studies in the last decade has shown that even when we are not engaged in any specific task, an ongoing intrinsic and structurally-organized activity characterizes virtually every cortical and subcortical structure (Cabral, Kringelbach, & Deco, 2014; Power, Schlaggar, & Petersen, 2014). In the free-energy theory this state of affairs reflects the continuous casting out of hypotheses about the causes of sensory input at multiple levels across the neural hierarchy (Sadaghiani, Hesselmann, Friston, & Kleinschmidt, 2010). Already Varela (1999) had proposed that the complex activity of the brain, continuously waxing and waning across the hierarchy of neural assemblies with specific time constants, would give rise to a fundamental temporal granularity of consciousness and time perception (see also Rodriguez et al. 1999).

Now, if the anticipatory processes concerning scenarios beyond the contingent situation are significantly curbed in *zazen*, one could predict that the driving pulse of the a priori expectations, the ‘transcendental rhythm’ (Khachouf, Poletti, & Pagnoni, 2013) would be altered as well, thus causing a phenomenological alteration of time perception. Does this correspond to your experience? How is time perceived during intense *zazen*?

FTG Using a figurative language, I call it the ‘section of time’. A bewildering section, a section of entire eras, like sitting on the edge of the Grand Canyon with your legs dangling over the void. In a single moment you see whole epochs cut through, and you are in all these epochs, somehow. We are used to conceive time as a line

or a segment, going from this point to that point; time has a dimension, a length. But when you are absorbed in *samādhi* — *zazen* is *samādhi* — you are engaging in a ludic activity and when you play, as everybody knows, time flows differently.

The explanation that my teacher gave me, which I subscribe to, is that *samādhi* ‘chops’ the time segment down to minuscule portions. When these portions tend to zero, time should essentially vanish and at this stage, my teacher used to say, you have the distinct impression that time becomes space and a feeling of complete stillness, like a lizard on a wall. The Heart Sutra’s rendition is “form is none other than emptiness” (Jap. *shiki soku ze kū*), “emptiness is none other than form” (Jap. *kū soku ze shiki*): time dissolves into space, and that space becomes time once again in all its phenomenological richness.

Zazen and dreaming

GP To my knowledge, in virtually all Buddhist meditative schools there is a sharp distinction between dreaming and the meditative state, even though, as most meditators know, it is often all too easy to slip from the calm condition of quiet sitting to a hazy state of daydreaming.

In the predictive coding scheme, dreaming has been interpreted as a way to optimize the internal model in term of its complexity (Hobson & Friston, 2012), a process that depends crucially on having both sensory input and motor output gated. Optimization of the internal model involves pruning of unnecessary synaptic connections; the model is optimized when it represents the causal structure of the world in a parsimonious way, a necessary feature for it to be able to generalize its predictions effectively across different situations.

According to the theory, predictions are still being issued by the internal model during dreaming, but the (large) discrepancy between prediction and actual sensory data is not propagated forward as prediction error because the gain on this channel is turned down by a decrease in aminergic modulatory transmission. This may be the reason why we are not surprised by the odd content of our dreams while we are dreaming them: the discrepancy with the actual sensory input does not generate a propagating prediction error (except for an *ocular proprioceptive* prediction error that is ‘explained away’ by the characteristic eye movements of REM sleep). The reduction of aminergic modulation that takes place in sleep and tunes sensory prediction errors down is accompanied by an increase in cholinergic modulation that raises the gain of prediction errors in higher cortical areas. These neuromodulatory

changes facilitate the optimization of the internal model by pruning the synaptic connections that are redundant and thus reduce its complexity.

I think that *zazen* may share some features with dreaming, but be radically different from it in other aspects. As in dreaming, overt movement (barring subtle postural adjustment) is curtailed, as is the variance of external stimulation (even if the eyes are kept open, the gaze is typically directed at an empty wall). On the other hand, the maintenance of a heightened but non-specific attention should boost, rather than dampen, the gain of sensory prediction errors, in particular for proprioceptive and interoceptive channels; furthermore, the prescription of not to become engrossed in spontaneous thoughts and mind-wandering — i.e. in the predictions from the internal model concerning non-contingent scenarios — may prevent the formation of a cycle of self-reinforcement, whereby thoughts get confirmed by other thoughts by coalescing into a coherent narrative or conceptual structure. Again, this would be mediated by a shift of attention from the content of thoughts to the sensory signals.

It is thus possible that *zazen* promote the optimization of the parts of the model that are involved more specifically in predicting the interoceptive and proprioceptive aspects of our lived experience, which are core components of our emotional life. Also, experiencing the spontaneous arising of mental content while maintaining the posture, may facilitate an adjustment of the overall a priori structure, that is, of the internal model, *in the context* of a vigilant, active attitude, thereby increasing the probability that such adjustments will induce actual behavioral changes outside the sitting session. In other words, *zazen* may facilitate the optimization of the emotional, situated and embodied aspects of our internal model. Does this make sense to you? Do you feel it is correct to say that in *zazen* the sensory channels are somewhat amplified by attention?

FTG The sensory information is definitely not gated in *zazen*: eyes and senses are kept open, and you look forward *not* to restrict your field of view but precisely because you don’t want to neglect either your left or your right side (when you look to the right you typically forget the left side, and vice versa). During *zazen* you look forward not to forget anything and anybody. It is not the attitude of excluding *a priori* the effect of perturbations: quite to the contrary, you render yourself extremely sensitive to them.

However, this kind of sensitization concerns not only the sensory data but also the mental, endogenous material. In fact, after an initial phase characterized predominantly by sensory attention, what could be called

‘the chaos of world’ makes its appearance, except that it is not perceived as chaotic anymore. Deshimaru used to say that the essence of the mental state in *zazen* lies in the *passage* between the rational, measuring faculty of the mind (Jap. *shiryō*), and its non-rational, intuitive aspects (Jap. *hishiryō*). Perhaps the uncovering of the a priori material during both *zazen* and dreaming is a common point between the two states, albeit to different effects. From this perspective, it is interesting that dreams were considered the foremost source of premonitions in many traditional cultures.

Another important quality of the mental state during meditation has to do with the reaction to the unexpected. If *zazen* is intense, a sudden loud sound such as the beating of the big temple drum does not startle you; it does startle you, on the other hand, if you happen to be daydreaming or dozing off.

GP This is very interesting because in the free-energy interpretation of REM sleep by [Hobson and Friston \(2012\)](#), even though the odd content of dreams is neurochemically prevented from eliciting surprise, the brain does respond to an external sound with a pattern of activity usually associated with the startle reflex (a ponto-geniculate-occipital wave); furthermore, contrary to what happens in the waking state, this startle response *does not* habituate with repeated presentation of the stimulus ([Bowker & Morrison, 1976](#)). Therefore, although we are unable to be as surprised by the content of our dreams as we would be if we experienced it while awake, at the same time it seems impossible for us to become *bored* by it, as anybody who has had recurring dreams can attest.

It appears as if during *zazen* there could be a simultaneous adaptation — the sensory prediction error has a high-precision and can thus effectively promote changes in the priors — and optimization of the internal model, the latter facilitated by the immobility of posture and gaze. The study of the startle response during *zazen* is a very promising avenue, in my opinion, for acquiring further insight into the relationship between predictive processes and meditation.

Harnessing chaos: unpredictability and ritual action

GP Living organisms are resilient to disorder: we have seen that they manage to accommodate perturbations by minimizing free energy. I wonder if ritual can be understood as an attempt to resist disorder at a higher, supra-individual level. The ancestral man lived constantly exposed to the threat of dissolution, and rituals may have developed as a *cosmetic* practice of injecting

order (Greek, *kosmos*) into a world perceived as dangerously unpredictable or chaotic. Ritual, rhythm and art are all characterized by a certain measure of regularity, and all derive in fact from the same Sanskrit root *ṛta*, which designates the order of the world.

FTG The problem is that ritual runs the risk of becoming just a concept. But the essence of ritual is *performative* and very demanding. I would even say that the ritual attitude is the only viable, non-excluding attitude towards life. It takes into account the eventuality of a variation — it does *not* remove the prospect of variations, as we tend to do in everyday life — but at the same time it gives the impression of being a repetition of something that took place during a time that we are not, and we will never be, privy to. It does look like a contradiction.

GP I was thinking about this too. The last verse of Euripides’ tragedy, *The Bacchae*, reads: “What we look for does not happen; what we least expect is fashioned by the Gods.” There seems to be indeed a profound connection between the nature of our mind constantly predicting what comes next and the notion of the sacred as what cannot be framed by our predictive powers and eludes our tendency to reduce experience to the already known.

As you pointed out, the situation is paradoxical. Ritual, the canonical gateway to the sacred, is characterized by a procedural skeleton that is quite rigidly prescribed and therefore predictable. However, the presence of strong constraints is also likely to free up some aspects of cognition. Perhaps, in trying to adhere to the prescribed sequence of actions with the utmost attention, the officiant becomes exquisitely sensitive to what is *not* predicted by the rules, to the perturbations.

FTG Ritual means indeed ‘repetition’, ‘repeated action’. But for the ritual to work, it needs to be the outward face of a spasmodic internal tension, which is born out of non-repeatability. It is only because of non-repeatability that repetition makes sense. Something that can be repeated acquires the ontological status of truth, but it is not simply a repetition compulsion that lies at the heart of ritual: we are somehow stalking a causality that comes before any idea of causality. Even though repetition compulsion itself seems to have a therapeutic valence in many psychiatric disorders characterized by a high level of anxiety: through repetition you recreate the world, and this turns out to be deeply reassuring.

GP Repetition compulsion as a strategy to cope with the deteriorating causal structure of world, by re-introducing order. It is as if the ritual manifested the archetypal causality among events which is really one of the most fundamental a priori of the mind.

FTG And this involves re-activating, re-enacting the chaos, before putting things in order. In the predictive coding scheme you have been describing, I would place ritual closer to perceptual than to active inference. As in perceptual inference, attention to the sensory data is heightened and, while you do act and the act itself seems repetitive, it is not confirmative. In fact, during ritual, you are treading on the edge where things may always turn out to be different than expected: the ritual must lead you into a different space, a different time.

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