

Structures in Consciousness

MICHAEL TRESTMAN, PhD

Latent Holdings

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ABSTRACT

This manuscript explores the structures of time and self consciousness through formal phenomenological analysis. I examine critical properties of subjective time such as depth and flow, and define the structure of the moment as the temporal unit of experience. Further I explore how temporally deep experiential phenomena such as episodic memory and prospection, planning, and perspectival empathy unfold within each and across moments, and how the multiple layers of self-directed and other-directed intentionality emerge from the interplay of consciousness with the unconscious latent state of the being's organic grounding.

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I INTRODUCTION

Aims

The goal of this manuscript is to understand and formally model the experience of being alive, conscious in the mind of a human being. I approach the territory of the mind as a cartographer, an explorer and map-maker, attempting to carefully name and track the parts of the mind and relate them to one another, and to describe how they change.

This general project is intended in part to support other projects, such as studying consciousness in nonhuman animals and problems related to assessing their welfare, as well as safety and policy research oriented toward humans. All of these areas depend on having a theory of the mind in place; particular projects tend to embed assumptions about how the mind works, since investigating how it works is not the focus. But ultimately, one cannot make a serious attempt at studying what someone else would or would not think or feel without studying one's own thoughts and feelings and the processes by which they arise. This is clear if only for the reason that one must know one's own mind to avoid naively projecting one's beliefs and preferences onto others.

Time and Self

. If this work has a theme, it is that time and self are dimensions of all conscious experience. If it has a central claim, it is that the self is many-layered, and the inner-most self of all conscious beings is fundamentally temporal: it is a self that dwell in time and moves through it the way a little fish moves through water

Time and self are structural axes or dimensions in consciousness:

1. Within every moment of experience, consciousness includes layers of the past and future; Life arrives as a stream of moments. The stream of moments has a distinctive directional flowing quality, and the flow property somehow carries across distinct zones with rather different qualities, the past, present, and future.
2. The world has layers of otherness, dividing self-from non-self background, other things, and other individuals with their own 'self'. Relationships to things and events tend to have a self-anchored 'push' or 'pull' toward them, judging them as bad or good, and orienting in time to the attraction or avoidance of events in relation to this badness/goodness.
3. Self and non-self have observed and hidden aspects.

Within and across times (hence in a orthogonal dimension to time), things, events, and signals seem to be arrayed along a self-nonself axis that splits the world from the body and

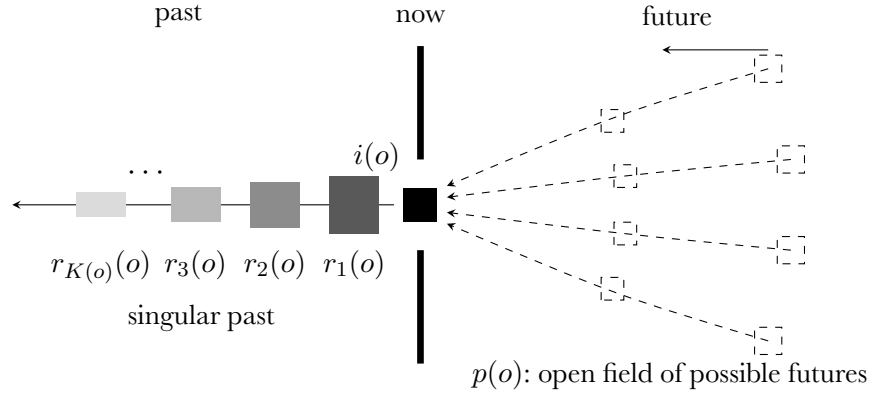


Figure 1: The present as an aperture: a plurality of anticipated possible events stream toward it from the many directions of the open subjective future $p(o)$ (dashed), collide with the primal impression $i(o)$, and collapse into the subject past, a series of retained impressions of prior moments: $r_1(o), r_2(o), \dots, r_{K(o)}(o)$

ones own actions from external happenings, and sensations within the body from events outside impinging indirectly. Along this dimension there also exist other loci of selfness, other selves that have inferred 'interiority' analogous to our own. Selves, both one's own and others, have layers of physicality, sensitivity, intentionality, emotionality, etc. What does it really mean for one self to know another, to be able to empathically 'take their perspective'? We must first understand the structure of our own experience to build an account of how awareness of another experience analogous to our own unfolds within our experience.

A boundary or horizon may also be noted which splits both self and world along a conscious/nonconscious axis. One's own self has a hidden interiority of subconscious and non-conscious layers. Other sentient selves, as well as mere inanimate things, also have latent state that changes how they behave and interact with us, and hence which can be experienced indirectly. Even among the ways something could appear to you, if it really is a *thing*, some of those ways it could appear ('aspects') must be hidden. We distinguish between a thing, an object in the world with physicality and objective existential actual realness, and 'appearance', a subjective way that the thing could appear to someone in a specific situation, because one thing has many ways it could appear and still be the same thing; they cannot possible all be known for any real thing; but to the extent that it is a thing, these appearances must be bound together in some regular way that you can track apart from the background chaos of the world. a thing is not just a pattern, but a certain kind of pattern of patterns.

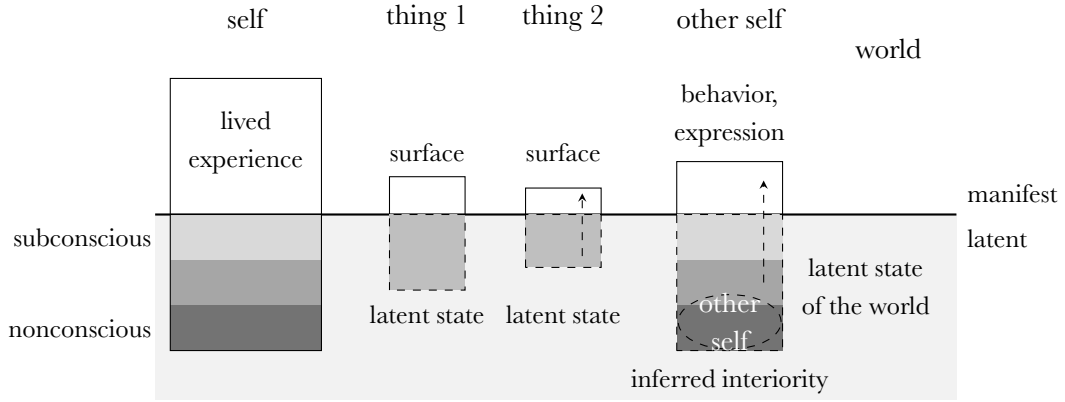


Figure 2: In any finite sequence of lived moments: the manifest and hidden sides of self, world, and others.

II TIME EXPERIENCE

The Flow of Time

Any direct acquaintance with experience confronts us with the flow of events from future to past. Sit and breathe, relax all your goal-directed intentions, and you are left with a field of passage, where thoughts, feelings and intentions drift by like clouds (Hanh 2008). This flow itself is your truest inner nature as a conscious being, in the sense that all other layers of thought, feeling, awareness of your body and the world, unfold within it. The layers of your self are built around your innermost core self as a being that persists from moment to moment. This is what allows you to accumulate other layers of selfness as well as relations to other things, events, and people. We can therefore reason that the temporal structures of consciousness are widely shared, perhaps by all conscious beings.

Layers of knowledge of self and world are built up inside this domain, one moment at a time. Anything we experience is potentially added to a reservoir of memory, where it can be reanimated to shape lived experience. You could also see or hear something that you will never forget, so each moment of life potentially shapes the way you receive new experiences for the rest of your life.

Perhaps the first thing to notice is the mysterious quality of *temporal depth* in our experience: that the contents of experience always overflow its duration, i.e. we are aware of more time than passes in a duration of experience. This not only true when you are thinking about the distant past or future, but in each moment. Hold your breath a bit longer than you normally would, and attend to the rising pressure you feel, and the building anticipation of relief, which 'passes' from anticipation to memory as soon as you act by allowing your breath to proceed.

Indeed, it seems that everything we experience as present is present against a background of what is just past. William James illustrated this with the example of hearing a crash of thunder:

“Into the awareness of the thunder itself the awareness of the previous silence creeps and continues; for what we hear when the thunder crashes is not thunder pure, but thunder-breaking-upon-silence-and-contrasting-with-it. Our feeling of the same objective thunder, coming in this way, is quite different from what it would be were the thunder a continuation of previous thunder. The thunder itself we believe to abolish and exclude the silence; but the feeling of the thunder is also a feeling of the silence as just gone; and it would be difficult to find in the actual concrete consciousness of man a feeling so limited to the present as not to have an inkling of anything that went before.” (James 1890 p. 149 ch 19)

What we are aware of most directly is not time in itself, but the passage, succession, and duration of events, (e.g. a flash of light, a sound or a feeling). Events occur and then pass. A particular objects may be present, then absent, then perhaps present again. Conditions can change.

Moreover, time does not contain just two alternatives, ‘present’ and ‘absent’ but has the structure of a linear *dimension*: occurrences are ordered. Any two things that happen are either simultaneous or happen in succession, one after the other.

But time is not all about change, as some things persist across time. Conditions can remain the same for a duration of time, and even when objects change, they often maintain an identity across time. Further, many events we are aware of unfold over extended periods of time; they have parts (beginning, middle, end) that are present and then past in succession.

Another classic example¹ is hearing a melody, a series of notes sung or played on an instrument, one after another. Though in one sense you can only ‘hear’ a single note at a time, whatever note is now being played, you still perceive the melody as a whole, even though it is spread out over time. You hear the note currently playing *as part of that melody*. This means that, although only one note is played at a time, the awareness of the currently playing note is accompanied by a lingering awareness of the sequence of previous notes. What notes we’ve heard so far shape our moment to moment expectations and the way we receive each subsequent note (and each fine, momentary phase of each note, each vibrato wiggle or pulse of volume or intensity). Each moment is therefore a kind of perspective that takes in on both a subjective past and future.

As James put it, “there is thus a sort of *perspective projection* of past objects upon present consciousness, similar to that of wide landscapes upon a camera-screen.” (1890 p. 406 ch 15). From one’s temporal perspective in the present one can ‘look back’ at the recent past, and also ‘peer ahead’ at an anticipated future. We will follow Husserl in calling this lingering

¹, introduced by Brentano and discussed by Husserl and a variety of authors (Dainton 2010)

awareness of the just past 'retention', and the anticipatory awareness of the future 'protection', in contrast to the 'primary impression' of the immediate present (1966).

So far we have identified several structural properties in consciousness, which we will now formalize and clarify as together making up the temporal perspective present within each subjective moment:

1. **Depth:** Within a single moment of awareness, there is awareness of other moments, there are intentional relationships or 'indices' to other moments referred to but not wholly contained within any given moment.
2. **Heterogeneity:** The depth of the subjective moment includes distinct zones of past, present, and future; the subjective relationship, i.e. the mode of access, to these moments is fundamentally different.
3. **Dimensionality:** Moments contained have succession or simultaneity relations, durations.
4. **Flow:** Events pass from the future to the past, with various asymmetries noted.
5. **Continuity:** The set of experiential moments across a lived trajectory are bound in distinctive ways.

Let $\mathcal{O}$ be the space of all possible conscious experiences, so the experience of any particular conscious being at a time is some $o \in \mathcal{O}$, where o comprises everything the subject experiences in that moment: sensations, perceptions, thoughts, feelings, memories, insofar as they are actually lived in the moment. A stretch of conscious life is then a finite path τ through $\mathcal{O}$:

$$\tau = (o_1, o_2, \dots, o_{|\tau|}), \quad o_t \in \mathcal{O}, \quad (1)$$

We can then represent the space of all such paths as $\mathcal{T}$, with some subset of it $\mathcal{T}^L$, the set that is lived by a conscious being, either an actual creature living in our universe (in which case their experience is a member of the set of lived conscious experiential trajectories $\tau \in \mathcal{T}_A^L$), or merely a possible sentient creature consistent with the laws of psychology, a member of $\mathcal{T}_P^L$ but not $\mathcal{T}_A^L$.

Because $\mathcal{O}$ is the space of all possible experiences, it contains experiences that include any possible aspect of experience it's possible to have, i.e. any possibly experienced *quale*. In fact, if we understand *qualia* as all the possible *aspects* of experience, all the ways a pair of possible experiences could differ, then each such aspect also corresponds to a subset $A_i \subseteq \mathcal{O}$: the set of all possible experiences that share it. So then we can think of each such $A_i \in \mathcal{A}$ as a signal or aspect of experience, some experiential event.

A trajectory through $\mathcal{O}$ is then also a trajectory through aspects: each moment o_t instantiates the family $\{A_i : o_t \in A_i\}$, and the stream can be read as the succession of these

families—the properties of consciousness as they are experienced, held, lost, and regained (Figure 3).

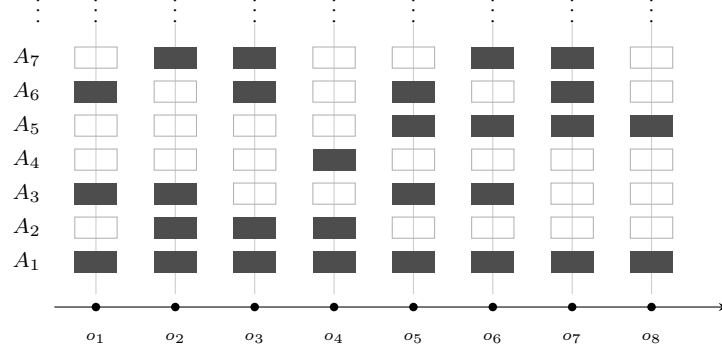


Figure 3: A trajectory through $\mathcal{O}$ is also a trajectory through aspects. Above each moment, its array of aspects $A \subseteq \mathcal{O}$, filled where $o_t \in A$.

Zones in Subjective Time

Now, as we have observed, our conscious experience has temporal depth: the contents of a moment experienced in a 'now' overflow the temporal extent of the 'now' itself. Each moment includes: the content given as 'in the flesh' anchoring the sense of nowness, subjective past that has sense of an ordered series of just-past moments, and a sense of an open future.

The moments that are the building blocks of subjective past and subjective future are similar in structure to the present and to each other. although our awareness of different moments of our lives is different, moments themselves (as conscious states we could be in) have a certain invariant structure that allows them to be present in each of those 'zones' (past, present, future) as in different 'modes' of access.

In other words, within the experience of particular moment, the subjective past and future are both made up of pointers or references to other moments, but the way they point is fundamentally different.

Each moment $o \in \mathcal{O}_{deep}$ has the following:

1. A 'primal impression' of the now, $i(o)$. This is the raw 'in the flesh' presence of lived experience that defines the now.
2. A subjective past $r_1(o), \dots, r_{K(o)}(o)$ with depth $K(o)$, formed recursively by the retentional modification operation μ .
3. A protention $p(o)$, the subjective future. This is a probability distribution over possible

future moments based on various ways things could go. It is an open ended expectation that moments will continue to succeed each other in ways that depend on what happened previously and how one reacts.

What ties the subjective future to the subjective past, making them parts or 'zones' of a shared dimension, subjective time? What distinguishes the subjective past from the subjective future?

A successful model must capture several phenomenologically important symmetries and asymmetries between the subjective past and the subjective future:

1. **Perspectival symmetry** we experience both the past and the future as a perspective projections, i.e an ordered fields of points that are themselves occupiable as hypothetical perspectives, which would yield another projection
2. **Topographical asymmetry** In the future zone events have a dimension of plural possibility/potentiality that is absent in the past, i.e. before a situation, multiple alternate possibilities could happen, but afterwards, only one of those will actually have happened.
3. **Flow asymmetry** events travel 'toward' oneself from the future and recede away into the past, and do so at a uniform rate, so that patterns or clusters of events in time maintain coherence as they slip from future to past
4. **Valence asymmetry** Plurality/uncertainty has a different character in the future and past directions; evaluation and agency are future-focused. What may happen *matters*, it often carries hedonic valence rather than being neutral (or not always/usually). Our natural tendency as sentient beings is to *strive* toward what is preferred.
5. **Causal asymmetry:** Dependency is layerwise from past to future.
6. **Choice asymmetry:** futures were h-argmined from past states, not vice-versa

The subjective past

Each moment, each layer of the retention updates; the first layer retains the prior moment's primal impression, and each subsequent layer retains what was at the corresponding layer minus one in the previous moment. Putting the primary impression at depth 0 as a convention, we can express this as a two-dimensional array indexed by time t and retentional depth k :

$$R_{t,k} = \begin{cases} i(o_t) & k = 0, \\ r_k(o_t) & k \geq 1, \end{cases} \quad (2)$$

Now the entire retentional dynamics is expressed compactly:

$$R_{t+1,k+1} = \mu(R_{t,k}). \quad (3)$$

Every retained moment slides one depth-step back into the subjective past per time-step by retentional modification. Therefore, the content at depth k is the impression from k steps earlier, modified k times:

$$R_{t,k} = \mu^k(i(o_{t-k})). \quad (4)$$

We display this as an array with rows indexed by time and columns by depth. We start at $t = 1$ with an empty retention, which is the limit case *null* depth moment. Each row is a single subjective moment's temporal field. Each column is a fixed depth. Each diagonal formed by a constant $t - k$ is the career of a single event as it sinks into the past:

	$k = 0$	$k = 1$	$k = 2$	$k = 3$
$t = 1$	$i(o_1)$			
$t = 2$	$i(o_2)$	$\mu(i(o_1))$		
$t = 3$	$i(o_3)$	$\mu(i(o_2))$	$\mu^2(i(o_1))$	
$t = 4$	$i(o_4)$	$\mu(i(o_3))$	$\mu^2(i(o_2))$	$\mu^3(i(o_1))$

(5)

Each field (t, k) describes a temporal phase of experience o_t , which *experientially refers to* another, previously lived, moment o_{t-k} , through the relationship of *retention* having been carried out k many times.

Hence the content of (t, k) can be computed: $\mu^k(i(o_{t-k}))$ (t, k) is the retained moment phase referring back to a primal impression originally experienced as k moments ago, now held, modified k -fold within the retention.

²

To return to the melody example:

“When the tone C is first heard, it is intended by the primal presentation. When it is succeeded by the tone D, the tone D is given in the primal presentation, whereas the tone C is now retained by the retention, and when the E sounds, it replaces the tone D in the primal presentation, whereas the tone D is now retained by the retention, and so on. The retention, however, is not simply a consciousness of the tone that has just passed. Every time a new tone is intended in a primal presentation, the entire retentional sequence is modified. When the tone C is succeeded by the tone D, our presentational consciousness of the tone D will be accompanied by a retention of the tone C (D(c)). When the tone D is replaced by the tone E, our presentational consciousness of the tone E will be accompanied not only by

²Compare Sonesson (2018, 44, fig. 1), which reproduces Husserl's (1966 [1928]) time-diagram extended in both temporal directions.

a retention of the tone D, but also by a retention of the tone retained in the tone D (E(d(c))), and so forth (Hua 10/81, 100).” (Zahavi 2005, p 57)

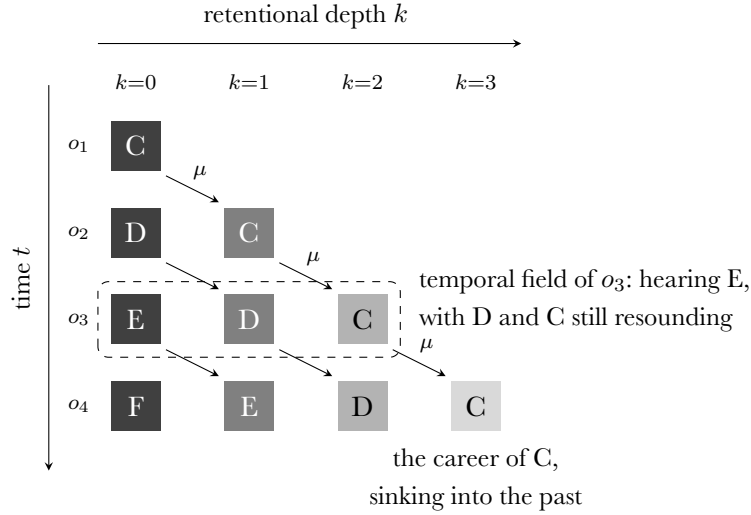


Figure 4: The retentive array (5) for a four-note melody C, D, E, F. Each row is one moment’s temporal field: at o_3 the note E is given as primal impression while D and C resound as first and second retentions, each dimmed by a further application of μ (arrows). Each diagonal is a single *note* sinking into the past.

So retention is iterative and recursive: every moment of experience contains a retention of the prior moment, which itself contains a retention of the prior moment, for a depth of some number of iterations (depth will be discussed below).

This iterated nesting constitutes the dimensionality of the subjective short term past. In this way a temporal sequence of impressions takes on the character of a flow of experience into a receding past that fades away from presence into absence.

The subjective future

Perhaps it is possible to be in a state of complete of uncertainty, or complete, precise certainty about exactly what will happen next, but most experiences lie between these limits; our expectations are somewhat uncertain; some aspects of the upcoming experience are anticipated with confidence and specificity and others may be more uncertain.

Moreover, when the future is divided, as it usually is, it is rarely divided in a way that *feels* neutral. Rather, we usually feel some degree of attraction to certain possibilities, and repulsion from others.

How do we model the dependence of the future on the past in consciousness, the expe-

rience of the dependence?

When I first encountered Husserl’s theory of the retention, impression and protention, I was a graduate student at University of California, Davis. Along the campus runs a beautiful arboretum and greenbelt where I would walk or ride my bike to get my blood flowing between long bouts of sitting with a book or laptop. A stream winds its way along the path, crossed by small several bridges. Under one, the path narrows to single file width just as it crooks around a blind corner, placid if murky water to one side and concrete bridge to the other. The approach presents a joined prediction-action problem that became a familiar example to me of the kind of problem we face all the time. At the same time we must guess what is on the other side, and hence what might pop into view at any moment, and we must act, moment to moment, choosing what to do with our bodies. What are the odds someone is coming on foot, perhaps on a bike? Or something less likely, a stroller or a wagon would not be too unexpected, a polar bear or triceratops would be less likely. What determines which of these possibilities flicker though our minds in such cases, and what role do such calculations play in bridging the gap between our memories, our expectations, and our actions?

Classical approaches to modeling decision under uncertainty have their limitations. For example, we can say that someone should do what they think is likely to produce the best outcome, but that doesn’t take into account that perhaps what they should do is get more information before choosing a course of action. A robust theory of rationality has to take into account the agent’s state of uncertainty and the fact that they have to gather their own information and evaluate the reliability of their sources themselves, in other words agents in the real world must be ‘self-evidencing’. A utilitarian theory says i should do whatever will have the best consequences, but it won’t help me figure out what consequences my actions will have, nor even describe the delimma that i face.

One thing it fails to capture is the perspectivalty of the subjective future, that it is made of moments, i.e. its nature as a prospective projection. In that way, the future is like the subjective past. Unlike the past, it is branching, and it branches based on both uncertainty about what we might encounter and choices we might make (see Figure 5).

We receive the future with some set of anticipations about what we experience next. These anticipations can range over any aspect of our experience, including what we will sense or feel or do next, or even what we might imagine. An anticipation is an experience we expect as possible, $\mathcal{A}_w^t \subseteq \mathcal{A}_i$, toward which we hold a certain *intentional attitude* that consisting of a credence $q_w(A)$ and a *hedonic divergence* weight $\lambda_w(A)$. *Valence*, also known as *affect* or *hedonia* is the experienced goodness/badness value of an experience. Here, we model the affective feel of subject w ’s experience o as its *hedonic divergence* $h_w(o)$, how far o diverges from what would be w ’s subjectively ideal experience.

So at a moment t , the combined state of any subject w ’s internal latent subconscious,

embodied individuality manifests as $\mathcal{A}_w^t$, a set of experiential anticipations, which projects a probability distribution and a hedonic divergence weight distribution over a space of possible experiences w could find themselves in.

$$(p_w, \lambda_w)$$

Where:

- $p_w : \mathcal{O} \rightarrow [0, 1]$ is w 's subjective probability distribution, assigning a probability value (0 to 1) to outcome o in the set $\mathcal{O}$ of all possible outcomes such that probabilities sum to 1: $\sum_{o \in \mathcal{O}} p_w(o) = 1$.
- $\lambda_w : \mathcal{O} \rightarrow \mathbb{R}_{\geq 0}$ is the *hedonic divergence weight* or *attachment value* of o for w ; i.e. how much being surprised in this way matters affectively

To capture the uncertainty of the subjective future and its entanglement with valenced affect (feeling) we model it as a valence-weighted probability distribution over possible future experiences, projected by a *generative model*, following Friston(...), that simulates trajectories into the future (see Figure 5).

The model consists of a set of states of concrete sensorimotor anticipation and activity (the set $\mathcal{A}_w^t$ for subject w at a time t), itself projected by a domain of doxastic, drive and doing states $\mathcal{D}_w^t$. $\mathcal{D}_w$ is w 's *latent state*, the nonconscious grounding of consciousness; it represents all of the states of brain and body as they bear on consciousness, the combined informational and motivational reservoir of a lifetime's learning and memory, as well as the 'instinctive' or evolutionarily derived knowledge embodied in the body's layers of epigenomic and genomic memory. How does all of this bear on consciousness, when it does?

Note that modeling an agent's state as valence-weighted expectation may be counterintuitive if one is accustomed to thinking of "beliefs" and "desires" as fundamentally different mental states, but there are distinct advantages. Here we combine the expectations implicit in *belief* and *desire* (or *goal-directedness*) together under a subjective probability function. Belief-like and goal-like are both *expectations*, differing in the level of *attachment* one has to them. *Beliefs* are expectations we are less attached to, and can easily revise without a fuss, whereas *goals* are expectations we are inclined to *work towards* by changing the state of the world, rather than give up.

Because on this formulation expectation ranges over the entire sensorimotor field, an agent's plans just *are* their conditionalized predictions about what actions they'll take in various circumstances. The generative model representation of the agent allows us to follow an agent's reasoning into their subjective future and understand how they make decisions based on trying to approach their conception of the good (their ideal subjective state, represented by minimal $h_w(o)$).

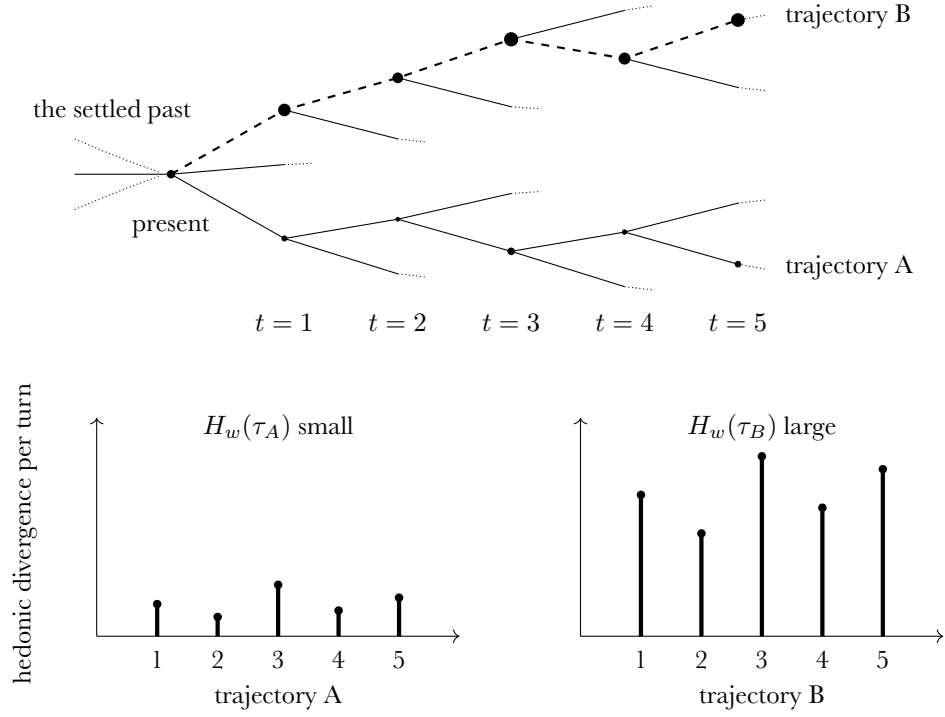


Figure 5: The structure of the branching future, branches weighted by their hedonic divergence.

Each anticipation contributes a factor to a candidate moment ((6)),

$$f_w(A; o) = \begin{cases} q_w(A), & o \in A, \\ 1 - q_w(A), & o \notin A, \end{cases} \quad (6)$$

Each surprised anticipation likewise adds a *charge* of hedonic divergence to the candidate moment:

$$\lambda_w(A; o) = \begin{cases} 0, & o \in A, \\ \lambda_w(A), & o \notin A, \end{cases} \quad (7)$$

The momentary distribution is the normalized product of those factors³:

³ $Z_w(o) = \sum_{o'} \prod_{A \in \mathcal{A}_w} f_w(A; o')$, the normalization constant: the sum, over all candidate moments, of the product of factors, so that (8) is a probability distribution. Each anticipation descends locally, from its own cluster of the latent state, and nothing upstream guarantees the results cohere; dividing by $Z_w(o)$ is the one place the live family is brought into a single distribution — the interface’s per-refresh act of reconciliation, and the closest thing the model has to a global state.

$$p_w(o' \mid o) = \frac{1}{Z_w(o)} \prod_{A \in \mathcal{A}_w} f_w(A; o'), \quad (8)$$

The hedonic divergence weight of a candidate moment is the sum of its charges:

$$\lambda_w(o') = \sum_{A \in \mathcal{A}_w} \lambda_w(A; o'), \quad (9)$$

Note that hedonic divergence weight is unnormalized where the distribution is normalized, because probability has no absolute scale and weight does.

Taking the negative logarithm of (8) turns the product of factors into a sum of shares,

$$-\ln p_w(o' \mid o) = \underbrace{\ln Z_w(o)}_{\text{reconciliation}} + \sum_{A \in \mathcal{A}_w} \underbrace{[-\ln f_w(A; o')]}_{s_w(A; o')}, \quad (10)$$

Anticipations are the experiential surface of our physical, biological, psychological reality, projected by w 's 'latent state':

$$m_w = \left(\mathcal{D}_w, Q_w, \{r_u, \ell_u\}_u, \{\alpha_w(d), \gamma_w(d)\}_{d \in \mathcal{D}_w} \right), \quad (11)$$

We model the latent state of w as a finite family $\mathcal{D}_w$ of doxastic, drive and doing states. Each carries a credence Q_w over its joint assignments u , each of which lends credence $r_u(A)$, so:

$$q_w(A) = \sum_u Q_w(u) r_u(A). \quad (12)$$

The weights descend by the same schema, with $\ell_u(A)$ the weight a joint state places on A

$$\lambda_w(A) = \sum_u Q_w(u) \ell_u(A), \quad (13)$$

The hedonic divergence of a moment is the product of its hedonic divergence weight and its surprisingness:

$$h_w(o) = \underbrace{\lambda_w(o)}_{\text{how much I care}} \times \underbrace{[-\ln p_w(o)]}_{\text{how far from expected}} \quad (14)$$

It accumulates along a trajectory under a temporal discounting factor δ :

$$H_w(\tau) = \sum_{t=1}^{|\tau|} \delta^{t-1} h_w(o_t), \quad (15)$$

An agent chooses by choosing a successor to itself ((24)):

$$m_w^{t+1} = \underset{m \in \mathcal{U}_w(m_w^t, o_t)}{\text{h-arg min}}^w \mathbb{E}_{\tau \sim \pi[m]} [H_w^t(\tau)]. \quad (16)$$

A moment revises the model by a weighted Bayesian update, and revises it at the latent level: the trial is first credited to the states that predicted it, each joint state u taking the responsibility $\rho(u)$ for it ((27)), and the counting happens there ((25),(26)),

$$Q'_w(d=v) = \frac{\alpha_w(d) Q_w(d=v) + m_d(v)}{\alpha_w(d) + n_d}, \quad \begin{aligned} m_d(v) &= \lambda_w(o) \sum_{u: u_d=v} \rho(u), \\ n_d &= \lambda_w(o), \end{aligned} \quad (17)$$

Conviction decays once per moment:

$$\alpha_w(d) \leftarrow (1 - \gamma_w(d)) \alpha_w(d)$$

As noted earlier, the temporalizing structure of the retention-impression-protention complex is also what grounds the most fundamental form of self-awareness inherent to subjective experience, i.e. phenomenal consciousness (Husserl; Zahavi 2005; Trestman 2013).

In holding previous, current, and expected impressions (together with the retentions of prior retentions and protentions) together, the articulated sequence itself emerges as something which transcends any of the momentary impressions that can be present in it at a time. The articulated, sequential structure constitutes the streaming of consciousness, and it is the stream itself that is the subject, most fundamentally. The momentary impressions come and go, entering the stream and passing away after being retained for a few iterations. But the stream transcends any of these impressions, and is in a sense aware of that transcendence precisely because of the multiplicity of impressions and their transience, which is represented in the sequential asymmetry of the structure of iterated retentions. (Trestman 2013; Zahavi 2005)

In the transience of events, which come and go in the temporal streaming of experience, one is confronted with the relative permanence (and hence reality) of the stream itself. An awareness of the transience of experienced events hence constitutes a kind of basic awareness of the stream by itself; in being aware of the transience of events, the stream is aware of itself as that which persists, that in relation to which events in time are transient. One's conscious self, one's self-as-subjectivity, just is the persistence of the stream of coming and going perceptions and worldly events they are understood to constitute. One's conscious self is the streaming, temporalized perspective one has on the experienced world. Hence

the temporalizing structural complex of retention-impression-protection underlies subjectivity itself; that structure makes it so there is ‘something it’s like to be’ a given cognitive system, to use Nagel’s (1974) formulation. This temporalizing organization is quite essential to phenomenal consciousness.