Time Slows Down in Nows Deprived of Their Anticipatory Faculty

Susie Vrobel
The Institute for Fractal Research,
Ernst-Ludwig-Ring 2, 61231 Bad Nauheim, Germany
Voice: +49 (0) 6032 3491746
Susanne.Vrobel@t-online.de

Abstract
Our present, which includes both our memory of the past and our anticipation of the future, consists of nested Nows which, on every nesting level, host both retentions and protentions (memory of the past and anticipation of the future). These nested Nows form our observer participant perspective. The degree of attention given to retentions and protentions in our current Nows determines whether our temporal perspective, which is generated by the superposition of nested Nows, focusses more on the past or on the future. Several correlations are described between the balance of retentions and protentions in the Now, perceived temporal speed, temporal dimensions generated, compatibility between levels of description, the observer's mood and perspective and his Now's anticipatory faculty. The common denominator which links these is our nesting speed, i.e., the rate at which we generate Δt_{depth}.
Keywords: fractal time, retentions, protentions, moods, perspectives.

1. Introduction: Temporal Observer Perspectives

In Lewis Carroll's *Through the Looking Glass*, the White Queen says to Alice: "It's a poor sort of memory that only works backwards" (Carroll, 1872). In this paper, I shall try to show that she has a point, as our memories contain both past retentions and past protentions, i.e., memories of the past and anticipations of the future (albeit it not in equal proportions), which are nested in our Now, our temporal window in which we generate reality. In addition to nested retentions, which consist of a nesting cascade of past retentions and protentions, the Now also contains the current protention. Together, they shape our anticipatory faculty.

Our temporal observer perspective, our Now, is generated by embedding our memory, which consists of past retentions and past protentions, into our current Now. At the same time, these elements of our memories shape the interfacial structure of our current Now and thus determine the way we generate new experiences (which are then embedded in the next Now, i.e., our next contextualization). This simultaneous top-down and bottom-up causation generates the emergent structure of our Now.

Retentions and protentions are often understood as the structural prerequisites for temporal experience, devoid of content (Gallagher, 2003) rather than as meaningful structures which rub off their positive and negative connotations to the next embedding

level, the next Now. The German phenomenologist Edmund Husserl defines retentions and protentions (as well as our consciousness of the present) as modes of empirical knowledge (Husserl, 1928). These modes relate the *Zeitobjekte* (time objects) we perceive successively. In this paper, I shall use a concept of retention which is inextricably linked with its content: The content of the retention shapes its internal structure and complexity. At the same time, the relative rate of temporal nesting performances influences the content of our Nows. This interpretation of retention is consistent with Emrich & Dietrich's definition of retention as a "recall of the past" (Emrich & Dietrich, 2005). If the structure of retentions were independent of their content, it would be hard to see how positive or negative content might rub off, i.e., how it could colour our current Now without assuming that this content is structurally mapped between nestings.

Positive and negative retentions generate different observer interfaces, as they determine whether our Nows are shaped by positive or negative anticipation of the future. In the next nesting, the current Now becomes part of our memory and colours it in a positive or negative way. This embedding performance results in either positive or negative feedback loops, which determine the structure of our current Now. If we are stuck in a groove of positive or negative feedback, our Now's anticipatory part leads us to form a positive or negative interface. Unless a profoundly strong stimulus catapults us out of this rut, we tend to amplify our positive or negative anticipations. This is important because positively or negatively connotated protentions create different observer perspectives and thus generate very different realities. The internal structure of our memories, i.e., the distribution of nested past positive and negative retentions and protentions, determines whether our Now leads us to take on a global or a local perspective (Gasper & Clore, 2002) and whether it has an impact on our reaction to old and new, i.e., known and unknown, stimuli.

The distribution of nested positive and negative retentions and protentions also seems to affect our experience of time. Depressed individuals' ability to integrate negative items into a positive context is incapacitated. Their interface favours known contents as opposed to unknown ones, i.e. they anticipate negative items more than positive or neutral ones. This means their nesting capacity is compromised or lost when faced with unexpected, i. e., positive, events (Emrich & Dietrich, 2005). In terms of my Theory of Fractal Time (Vrobel, 1998), these observers lack the ability to generate simultaneity, i.e., Δt_{depth} (the number of nestings of compatible events) when faced with unexpected events. Instead, they generate succession, i.e., Δt_{length} (the number of compatible events on one level of description (LOD)).

Dominance of the past in depression correlates with the subjective experience that processes appear to slow down. Time slowing down may be portrayed as succession being generated rather than simultaneity. Although there is no known direct causal link between the ability to nest unexpected events and an altered experience of time, a correlation between the two phenomena can be described in terms of an individual's nesting capacity. A depressed individual's interface seems to lack this ability. Thus, his Now, which is deprived of its anticipatory faculty, is characterized by both the phenomenon that unexpected events are not nested and that processes appear to be

slowed down. Both phenomena may be described as the failure to contextualize, i.e., the inability to generate Δt_{depth}. Instead, a "lining up" of incompatible events on one level of description (the generation of Δt_{length}) occurs. This correlates with the subjective feeling of time slowing down (Vrobel, 1998).

Protentions allow us to perform a reality check. If our expectations are met, the prevailing positive or negative interfacial structure is reinforced and may, at some point, become hard-wired. If our expectations are not met, no reinforcement takes place, but the interfacial structure may be modified with the next embedding performance.

Positive and negative moods shape our current observer perspectives. Moods may arise from, among other causes, an unbalanced distribution of retentions and protentions in our memories. This particular relation may also be described, on a different LOD, in terms of relative nesting speed. Without protentions, there is no generation of Δt_{depth}, i.e. no nestings occur. If the difference in nesting speed, i.e., the rate of contextualization performances, is the defining factor for distinguishing between observer perspectives, those moods which arise from successful or unsuccessful contextualization attempts may be seen as a manifestation of this relative nesting speed.

In general, we may say that the notion of perspective entails that of an observer generating depth. This is true for both spatial and temporal perspectives. I am suggesting that the underlying factor which determines our observer participant perspective is our ability to nest events and, thus, generate Δt_{depth}. In fact, it looks as if this ability is a prerequisite for cognition. Nested systems such as a fractal Now consisting of a nesting cascade of retentions and protentions contain a model of themelves. For Robert Rosen, to contain a model of itself is a defining property of an anticipatory system (Rosen, 1985), in fact, it is his definition of a living system. Daniel Dubois has generalized the notion of anticipation by extending it to non-living systems and thus making it a property of the physical world in general. Dubois differentiates between weak and strong anticipation. Weak anticipation is based on a model of a system, whereas strong anticipation is generated by or embedded within the observing system itself (Dubois, 2000, 2003). An observer perspective shaped by a fractal Now is an example of strong anticipation, as the retentions and protentions form a nested structure which generates a new embedding LOD with each new iteration (contextualization). Both the distribution of retentions and protentions and the relative speed at which we are able to perform these nestings determine our anticipatory faculty.

As scientists who develop scientific theories are observer participants whose perspectives arise from embodied interaction with their environment, i.e., from generating Δt_{depth}, it may be worth looking into the fact that these scientists are blessed with differing anticipatory faculties, and therefore come up with differing models of reality. These models will vary, depending on whether scientists' interfaces give preference to a global or a local perspective, whether their ability to react to known and unknown stimuli in a differentiated way is compromised and whether their subjective experience of duration, which is determined by the observer participant's ability to generate Δt_{depth} is in line with that of their environment. Our ability to generate Δt_{depth} forms our anticipatory faculty, whose existence we usually only become aware of if it is

compromised, e.g., if our nesting rate is not in line with that of our environment (Vrobel, 2005).

2. Retention, Protention and the Fractal Structure of the Now

Reality generation happens within our Now, our temporal observer participant perspective. We generate this perspective by embedding past Nows into current ones, thus creating a nesting cascade of Nows. This idea was first expressed by Husserl, who defined an extended Now which hosts both retentions (our memory of the past) and protentions (our anticipation of the future) (Husserl, 1928). He exemplifies this idea by the way we perceive a tune. We do not just hear a succession of unrelated notes, but a tune, because we connect the note that lingers with the one we currently hear and the one we anticipate to follow it. When we perceive the next note, we nest the previous one into our retention cascade, and so on. The emerging fractal structure of nested Nows forms our observer participant perspective. (Of course, Husserl did not use the concept of a fractal, which was coined half a century later by Mandelbrot (Mandelbrot, 1982), but he implicitly described this notion.)

Every Now consists of both retention and protention, every nested past Now retains this structure when it is embedded in the next Now. Therefore, no matter how deeply nested, every retention contains not only past retentions but also past protentions. At the same time, our protentions are expectations which are heavily coloured by the nested retentions in our current Now: When we hear a note in a tune, we expect that this was not all and that another note will follow, on the basis of what we have heard up to this point. Nested retentions and protentions thus form the fractal structure of our Now. This Now is not a point which separates the past from the future, but is extended, as it hosts both retentions and protentions.

My Theory of Fractal Time takes account of the nested structure of the Now and allows for an objective description of subjective duration. When we imagine our Now in context, we usually conceive of it as a point or (for an extended Now) an interval on an imaginary line extending from the past to the future. If my mother tongue is German or English, I imagine the past on the left side of the Now and the future on the right. If it is Arabic, I imagine a timeline which places the past on the right and the future to the left of the Now (Hafez, 2007). Our writing direction apparently determines the direction in which we imagine time to flow from the past via the Now into the future.

I have suggested giving up these arbitrary directions from left to right (or right to left) when we imagine our Now in a temporal context and rather replacing them with a direction which runs from the inside to the outside (Vrobel 2006a). In a model of nested temporal bubbles, past Nows are nested into more recent ones, with the current Now forming the outer boundary of this nesting cascade. In this model, a further differentiation in the notion of time is necessary, i.e. that between succession and simultaneity. The imagined timelines I have just described portray succession only. If we were to add simultaneity, we would have to imagine parallel timelines. In contrast to this view, in my fractal model, succession and simultaneity are two independent extensions, i.e. temporal dimensions which are mutually exclusive. They generate the

length and depth of time, Δt_{length} and Δt_{depth}, respectively. Over an interval of time, the relative distribution of succession and simultaneity determines the density of time, measured in its fractal dimension ($\Delta t_{density}$).

In a nutshell, my Theory of Fractal Time differentiates between Δt_{depth}, Δt_{length} and $\Delta t_{density}$. Δt_{depth}, the depth of time, captures simultaneity and is measured in the number of nestings of compatible events on several levels of description. Δt_{length}, the length of time, describes succession and is measured in the number of incompatible events on one LOD. $\Delta t_{density}$, the density of time, describes the relation between succession and simultaneity over an interval of time and is measured in the fractal dimension of this interval (Vrobel, 1998).

Table 1: Fractal Time

temporal dimension	**extension**	**measured in**
Δt_{depth}	simultaneity	compatible events
Δt_{length}	succession	incompatible events
$\Delta t_{density}$	comprises Δt_{length} and Δt_{depth}, i.e., the relation between simultaneity and succession for a certain interval	the relation between compatible and incompatible events, the fractal dimension of a certain interval

In this model, the only direction in which time flows is from the inside to the outside, extending either into the dimension of Δt_{length} (succession) or into the dimension of Δt_{depth} (simultaneity). Extension in Δt_{depth} occurs with every new nesting, which creates a further simultaneous LOD, i.e., a new contextualization. Succession makes the current Now of the nested bubble grow from the inside to the outside (imagine it as a 2-dimensional cut through the 3-dimensional bubble – a circle which widens its circumference with every new successive event), but without creating new nestings.

Here is an example of how fractal time manifests itself. Observers with high nesting capacities perceive duration differently from those who lack nesting abilities. The latter do not necessarily end up as pathological cases, as this difference in nesting capacity does not need to be permanent. Sometimes, the momentary context we are embedded in triggers nesting for some but not for others. When we recollect and newly arrange past facts on new LODs, Δt_{depth} increases and Δt_{length}, by contrast, contracts. During a class reunion, for instance, time seems to fly for the former class members, as they generate primarily Δt_{depth}. By contrast, the pitiable families of the former class members generate primarily Δt_{length}, as they cannot contextualize their spouses' recollections into their current Nows. This leaves them arranging everything they experience on a constant number of LODs - in other words, bored stiff (Vrobel, 1998).

Simultaneity adds a dimension to succession by making succession multi-levelled. When we relate simultaneous and successive events in a certain interval, the resulting perspective gives rise to its fractal dimension, the density of time, $\Delta t_{density}$. There are various ways of determining the fractal dimension. The most general approach is Barnsley's box-counting method (Barnsley, 1988), as it allows us to define even plane-

filling structures in terms of their fractal dimension. It shifts fractality into the eye of the beholder, rather than linking it to an intrinsic property of the system to be observed. This is useful if we wish to describe a system from the perspective of an observer participant who generates reality from a time series. This perspective differs, depending on whether the observer looks at a system from the outside or whether he is embedded in the system which is the object of his study. The following differentiation between the views from outside and from within shows why it is necessary to define observer perspectives in terms of observer types and observer participant interfaces.

3. Endo- and Exo-Perspectives: Generating an Observer-World Interface

As observer participants, we are already embedded in the subject matter we wish to define: time. Therefore, a non-circular definition of time seems impossible. However, by comparing two incompatible perspectives, namely the views from within and from the outside, we are able to pin down the characteristics which define these perspectives and their limitations.

Within the framework of his endophysical model of the world, Otto Rössler introduced the concept of the endo-observer ("endo" meaning "from within") (Rössler, 1998). This observer type sees the exo-world (the outside world) from within, distorted by his interaction with this outside world. An embedded observer cannot access the exo-world directly – the exo-perspective is reserved for superobservers such as Laplace's demon. As the exo-observer is an idealized construct of an observer who observes without interacting, we can assume that we are all endo-observers.

Dubois differentiates between endo- and exo-anticipation and provides the following definitions for these notions (Dubois, 2000): Exo-anticipation is anticipation generated by a system about external systems. It may be based on a theory or on a model of the environment. Endo-anticipation is anticipation of a system's own behaviour, generated by or embedded within that system. Both free will and the anticipatory electromagnetic field are examples of endo-anticipation (with the electromagnetic field manifesting potentially both endo- and exo-anticipation, depending on the point of view).

So where should we set the temporal interfacial cut? As observer participants, we generate reality in an interactive way: Both our expectations about the world and the stimuli we perceive from the outside world together generate our personal reality, our Now. As Rössler put it: "Nowness is pure interface" (Rössler, 1995). After the Cartesian Cut, which separated res extensa from res cogitans and the Heisenberg Cut, which separated the observer and the observed, the Rössler Cut takes into account the microscopic movements within the observer as a source of distortion – it is an interfacial cut which manifests itself as our Now. Bohm suggests that the act of observation generates a holographic interference pattern which manifests itself to us as reality (Bohm, 1980). In order to generate such an interference pattern as a result of our integration performance, at least two sources must be assumed to interact. The amount of interference patterns generated depends not only on the number and complexity of stimuli from the outside world, but also on the internal complexity of the observer. The

structure of his interface determines the degree to which the exo-world we perceive is distorted in our endo-perspective. The endo-observer may be said to simulate the exo-world by means of an internal model of this exo-world, which is based on his expectations. Endo-dynamics simulates exo-dynamics in an attempt to establish a coherence between the observer participant and the observed environment (Schmidt, 1998). In this paper, the interfacial cut is set by the observer participant's Now.

Below (Section 6), I suggest that the structure of an observer perspective is primarily determined by the temporal dimension of Δt_{depth}. This is so because Δt_{length} plays no part in interaction: it is generated by the internal feedback loops of an observer boiling in his own broth. Only simultaneity between the endo- and exo-world generates interference patterns and thus a nested Now. Succession may be seen as an unsuccessful attempt at contextualizing, i.e., of creating Δt_{depth} by means of nesting performances.

We cannot directly access the exo-world. All interaction with the outside world manifests itself to us only as interface reality. However, we are able, within limits, to modify this interface reality by making our model of the world more complex, by growing new or more differentiated antennae, so to speak. In terms of temporal dimensions, this means generating Δt_{depth} by contextualizing, i.e., forming new Nows into which we embed existing ones. If our ability to contextualize is compromised, our interfacial structure becomes less complex. This condition breeds an observer type with a limited perspective. Below, examples are given of ways in which the observer's inability to generate Δt_{depth} may manifest itself. Note that these are my interpretations, and do not necessarily reflect the opinions of the researchers who performed the experiments described.

4. The Formation of Δt_{depth} is Compromised for Observers who Draw on a Memory Deprived of Protentions

In depression, the observer participant's experience is dominated by the past. Emrich and Dietrich carried out an experiment in which patients were exposed (on a video monitor) to a series of words with different emotional connotations. The corresponding event-related brain potentials (ERPs) were recorded (Emrich & Dietrich, 2005). Two groups – depressive individuals and a control group – had to decide for every word presented whether they thought it was new or had been presented before. Emrich and Dietrich found that the two groups responded differently to old and new words with emotional content ("old" meaning that the word was not perceived as new). Whereas control group subjects' ERPs showed significant differences when exposed to new and old words, in depressive patients' ERPs, differences were hardly detectable. Emrich and Dietrich's interpretation of these observations was that negative cognitions form the depressive patients' expectation: negative words were very much more expected than positive or neutral ones (negative memories in particular led to a dramatic reduction of old/new differences). It appeared that the ability of the depressive individuals to integrate negative items into a new positive or neutral context was incapacitated. In terms of fractal time, one may say that their ability to generate Δt_{depth} was compromised.

Emrich & Dietrich's findings may be interpreted to suggest that depressive patients have lost their ability to embed their (negative) past retentions and protentions into positive new contexts. In the experiment, the depressive individuals' ability to perceive a positive new stimulus was highly compromised. However, they did nest their past into stimuli with negative connotations (which their world-observer interface was conditioned to anticipate). Drawing primarily on the past in our Nows leads to an interfacial structure which is dominated by retentions. The longer this perspective persists, the deeper the nesting cascade of retention-heavy Nows grows. As a result, the observer participant's Now becomes deprived of its anticipatory faculty. He forms an interface which "misses" many a nesting opportunity, because he cannot perform contextualizations which change the structure of his nesting cascade of protentions and retentions, i.e., he resists contextualization and thus does not generate Δt_{depth}.

If an observer participant's ability to generate Δt_{depth} is compromised, time subjectively slows down for him, as new stimuli are arranged on existing LODs. No new LODs are generated, i.e., the past is not embedded into new ones. Rather than forming new LODs (Δt_{depth}), new, i.e. unexpected, stimuli are arranged on existing ones. This leads to an increase in Δt_{length}, which dilates time, i.e., increases duration for the observer (Vrobel, 1999). The resulting observer participant perspective is deprived of its anticipatory faculty, which manifests itself in an extended Now shaped primarily by succession, rather than simultaneity. It is a perspective which avoids contextualizations (Vrobel, 2006b). Another way of differentiating temporal observer participant interfaces is concerned with global and local perspectives.

5. Global and Local Perspectives: The Formation of Δt_{depth} is Compromised by Negative Moods

The observation that global perspectives arise from positive moods whereas local ones correlate with negative moods (Gasper & Clore, 2002) has as yet not been linked to the observer participant's perception of duration. However, both phenomena may be described in terms of nesting capacity and interfacial extensions in the temporal dimensions of Δt_{depth} and Δt_{length}. Gasper and Clore conducted an experiment in which participants were asked to state "whether a target object was more similar to an object that matched its global, but not local, aspects or one that matched its local, but not global aspects." Participants in sad moods tended to see more similarity between the target object and an object which matched its local structure, while participants in happy moods found the target object more similar to the one which matched its global structure.[1] The observation made by the experimenters that individuals in sad moods tend to see the forest and individuals in happier moods tend to see the trees may also be described, in terms of fractal time, as a preference for temporal dimensions: Sad moods evoke Δt_{length} and happy ones give rise to Δt_{depth}, i.e., sad moods resist contextualization

[1] This is a very simplified account of the experiment, which included more parameters and considerations, in particular, the fact that that these outcomes refer to task situations. For more information and detail, see Gasper & Clore, 2002.

whereas happy ones give rise to it. Happy moods appear to generate new sets into which we nest the perceived elements. Sets and elements are two simultaneously perceived LODS, which give rise to Δt_{depth} by nesting elements into sets.

Both global and local perspectives are endo-perspectives. Whether we perceive visual stimuli (as in the experiment described above) or auditory ones, the nesting or non-nesting performance of the observer is always a temporal one. Global perspectives arise because we create a new set, a new LOD into which we embed structures on a lower LOD, i.e., structures which are subsets of the global structure.

The observation that the mood of the observer participant determines the structure of his temporal interface may also be described in terms of his relative rate of generating Δt_{depth}. As positive moods correlate with a global perspective (one which favours nestings) and negative moods correlate with a local one, i.e., perceiving objects or events on existing LODs, perhaps there is an underlying mechanism which correlates with these perspectives in terms of the nesting speed (the generation of Δt_{depth}) of the observer participant.

This suspicion is supported by Pronin and Wegner's observation (Pronin & Wegner, 2006) that thought speed influences moods irrespective of positive or negative thought content. Their experiment showed that fast reading of a text improved the readers' moods, regardless of whether the text's content was negative or positive. This observation may be interpreted in terms of temporal dimensions generated during the reading process: Δt_{depth} is generated at a faster rate because subjects nest syllables into words, words into sentences and sentences into stories and thus create meaning by nesting. Further research (see the two experiments suggested in the Conclusion below) is necessary to support or disprove this interpretation. Possibly, global perspectives, which accompany positive moods, arise as a result of fast nesting. If moods are seen as an order parameter in Haken's sense (Haken, 1995), a change in the nesting speed of the order parameter's enslaved constituents may modify the order parameter and thus lead to a phase transition.

Table 2 shows the correlations described in this paper between nesting capacity (the generation of simultaneity) and compatibility, retention/protention distribution, perceived speed, moods, perspectives and anticipatory faculty.

Table 2: Correlations

temporal dimension generated	succession	simultaneity
compatibility between LODs	incompatible	compatible
balance of retentions and protentions	dominance of retentions	dominance of protentions
perceived speed	increase in the rate of Δt_{length} generated (time slows down)	increase in the rate of Δt_{depth} generated (time speeds up)
mood	negative	positive
perspective	local	global
anticipatory faculty	compromised	enhanced

6. Conclusion

The temporal dimensions of Δt_{depth} and Δt_{length} are mutually exclusive. Δt_{length}, i.e., succession, does not create nestings (Δt_{depth}), as there is no interaction with the outside world which generates new contextualizations. The observer participant's anticipatory faculty may be defined by the rate of Δt_{depth} generation.

The ideas and examples presented in this paper show correlations only. The connecting underlying notion of a temporal observer perspective which is determined by the distribution of Δt_{depth} and Δt_{length} is one way of explaining phenomena such as the subjective duration of our Now (Vrobel, 1998), our ability to differentiate between new and old (expected and unexpected) (Emrich & Dietrich, 2005), global and local perspectives (Gasper & Clore, 2002) and nesting speed (Pronin & Wegner, 2006). Further experiments and insights may show whether some or all of the phenomena described are interrelated and may be pinned down to the distribution of Δt_{depth} and Δt_{length} as a common denominator.

Here are two suggestions for experiments whose outcomes may support or disprove the existence of interrelations between the phenomena described:

1. Subjects are asked to quickly read a text which consists of nonsense words which cannot be contextualized (i.e., syllables cannot be nested into words, words into sentences or sentences into larger semantic contexts). Neither does it have a grammatical structure which may trigger nesting activities. If the subjects' moods do not improve, this would support the idea that it is not an unspecific processing speed, but nesting speed, i.e., a fast increase of Δt_{depth}, which is the determining factor that shapes our interfaces.

2. Subjects are exposed both to cascades of visual nestings and to visual stimuli which are not nested (e.g. zooming out of Google Earth and moving from one town to another on the same scale). The presentations should cover the same interval in Δt_{length}. If subjects experience a difference in duration, this would suggest that a local (i.e., non-nested) perspective correlates with longer relative (subjective) duration and the transition from local to global perspectives correlates with shorter relative (subjective) duration. In terms of fractal time, zooming out would generate Δt_{depth} as a result of contextualization and decrease subjective duration. Remaining on one LOD (one scale of Google Earth) would generate Δt_{length} as a result of the fact that no new sets are created into which elements (e.g. towns) may be nested. The lack of contextualization would increase subjective duration (Δt_{length}).

Regarding our anticipatory faculty, the differentiation between the temporal dimensions of Δt_{depth} and Δt_{length} is crucial. Without simultaneity, no contextualization would be possible and, thus, no construction of a nested Now. We would be stuck in the generation of Δt_{length}, remaining on one LOD, which results in a local perspective. In order to engage in anticipatory interaction, we cannot do without Δ_{depth}, i.e., the generation of a (nested) global perspective is necessary. A fractal perspective anticipates further nestings. The distribution of retentions and protentions shape the observer participant's interfacial structure and determine whether he is able to contextualize. A

retention-heavy Now (as experienced in depression) generate only little Δt_{depth} and gives rise to an observer participant perspective with limited anticipatory faculty. The same is true for observers with a local perspective. If their ability to generate Δt_{depth} is compromised, so is their anticipatory faculty.

The White Queen could not refer to our anticipatory faculty, as she had met neither Bob Rosen nor Daniel Dubois. However, her remark nicely sums up the result of a temporal observer perspective dominated by retentions.

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