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HOT, Conscious Unity, and the Structure of Events: Extending Friesen's Critique

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Friesen (2014) has examined Rosenthal's HOT (higher-order thought) theory of consciousness with respect to its capacity to support various forms of conscious unity, noting many difficulties. The problems facing HOT in three of these unities — subject unity, stream unity, and object unity — are extended in more detail here, with special attention paid to object unity as simply a special case of event unity. Rosenthal gives a HOT the power of uniting/co-representing multiple mental states. As Friesen notes, this co-representation must be relational; even an object unity such as a "red cube" would require at least a thought representing a location relation — "red at location x, cube at location x." This "relational" requirement is likely more fatal to HOT theory than Friesen took the space to explore. On analysis, the relations in even a simple event are so dynamic and complex, yet simultaneously so mutually implicatory via the abstract, amodal information that specifies the event in all modalities, that the notion of a co-representational HOT loses any notion of efficacy, necessity, or coherence.

Keywords: HOT theory, conscious unity, event stracture

Rosenthal's (2002) theory of higher order thought is well known for its insistence that a higher order thought (HOT) is required for turning a mental state into a conscious state. In Rosenthal's view, there are two categories of mental states: (1) a mental state with the thought that one is in this state = conscious or subjective awareness, and (2), a mental state without the thought that one is in this state = unconscious. Thus, for Rosenthal (2011): ". . . a state is conscious only if one is subjectively aware of oneself as being in that state" (p. 431).

When it comes to the explaining the unity of consciousness, Friesen (2014) has argued that HOT theory is far from adequate. Friesen firstly notes that there are two basic forms of unity — synchronic and diachronic — within each of which are multiple forms:

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Synchronic

1. Phenomenal unity, or conjoint/subsumptive phenomenology — the taste of the sip of coffee, the kitchen chair against my back, the view of table — all cohere or are subsumed in a unified experience.
2. Spatial unity — the table, chairs, walls, hanging pots, rugs etc., all cohere in a space.
3. Object unity — the form and color (white) of the coffee cup cohere.

Diachronic

1. Stream unity — as I walk from the kitchen to the living room, there is a flow that coheres.
2. Subject unity — I can think of the experience of reaching for the coffee cup as my own, as well as other experiences (e.g., breakfasts/coffee) in the past.

Rosenthal is proposing to explain *all* of these, Friesen notes, with but two basic mechanisms. The first of these is indexical. This is to say that the multiple mental states in the whole cohere by the fact that they are referenced to an "I," i.e., to a subject's sense of self. The second is co-representational. Thus, part of what unifies conscious states, per Rosenthal, is the fact that HOTs often represent many lower-order states all at once. Though Rosenthal has little to say about the precise nature of these higher-order representations, he maintains that HOTs "operate on many of our mental states not singly, but in large bunches" (2000, p. 226), i.e., a HOT can target and represent many different simultaneous mental states.

The multiple types of unity however are lost in Rosenthal's treatment, conflated into a generic "unity," and, Friesen argues, these two mechanisms — indexical and co-representational — are simply not up to the actual task, at the very least leaving Rosenthal a lot of fleshing out to do. Friesen makes numerous excellent points as he analyzes these mechanisms vis a vis the various forms of conscious unity. I will not do them all justice by far, focusing on only a few here, with the intention of showing that these arguments could have gone much deeper, so much so that any validity of the HOT theory seems to float on utterly inadequate attention to the nature of these "unities." The focus here will be the nature of our perceptual experience as emerging, for example, in the science of ecological psychology and the structure of events. Two secondary points will note the inattention to the relation of mind to time (an inherent problem once we talk of events and therefore stream unity), and to the profound problem within subject unity of what makes one consciously aware of previous events as part of one's past history.

Object Unity — as Events with Invariance Structure

The co-representation notion, Friesen observes, should apply even at the level of object unity, say, for a red cube. The redness (a mental state) and cubeness (a mental state) would be co-represented in the HOT, providing the unified experience of the colored object. We must presume here, he notes, that it is more than a simple conjunctive representation, e.g., "redness and cubeness," but rather at least a relational representation, to the effect, say, "cube and redness at location x."

This is the insight of Friesen that I wish to key on first, namely the requirement implicit within Rosenthal for what we can term *relational* HOTs to support object unity and by implication, even the unity of various aspects of an event. In broaching this subject, we enter into a region of great complexity. Rosenthal's theory, vague when addressing the unity of consciousness as effected via HOTs, must confront the actual dynamics and information defining events — those "episodes" that a HOT makes conscious. This is not just white coffee cups or red cubes. It is rotating red cubes, spoons stirring coffee, leaves falling and twisting or even leaves being raked across the lawn. In viewing the unity of dynamic events, the necessity for HOTs and their viability as co-representational agents or forces is brought very much into question.

Let us take one of those simple "episodes," i.e., an event, that a HOT is supposed to make conscious, in this case the simple act of watching oneself stir coffee in a cup with a spoon while sitting at the kitchen table. This event has a structure, a structure that must be supported in an ongoing way over the neural dynamics of the brain. We will be asking what a co-representational HOT could possibly be, such that it can turn this structure into a conscious perception. I have given an analysis of this event in other places (Robbins, 2002, 2014a), and intend to be more succinct here.

The event of coffee stirring is defined by numerous invariance laws; it is immensely mathematically rich. If the cup rests on a tiled table, it rests on a texture density gradient. The tiles are our texture "units" and have a decreasing horizontal separation (S) as a function of the distance from our eye ($S \propto 1/D$), and with a vertical separation as $S \propto 1/D^2$. These gradients are ubiquitous — beaches, fields of grass, tiled floors, rugs, etc. If the cup is moved towards us across this gradient, the size constancy of the cup as it moves is being specified, *over time*, by the invariant proportion, $S \propto 1/N$, where S is the (increasing) vertical size of the cup on the retina, N the (decreasing) number of texture units the cup vertically occludes ($SN = k$). When the gradient itself is put in motion, say, as we move our head towards the table, it becomes an optical flow field — a gradient of velocity vectors where there is an increasing point velocity as the distance from the eye decreases, $v \propto 1/d^2$, where all vectors are radiating from a single point, the point of optical expansion.

These optical flows are viewed as critical in the specification of dynamic form, as in a rotating coffee cup, and as our little coffee stirring scene is filled with forms, we should have some idea of what a co-representational HOT is presiding

over when it comes to these. Bear with me here, for we should see how dynamic, therefore constantly changing, this specification is. The flow-as-form insight came as a response to the intractability of the correspondence problem, a problem which required the tracking of the features of a moving object (and their position) from "frame" to "frame" in the object's motion. Were the object a rotating cube, the features would have been the vertices and edges of the cube. Adelson and Bergen (1985) described a general class of low-level models based on linear filters known as "energy models," initially developed by Watson and Ahumada (1983), addressed specifically to the detection of the direction and velocity of motion, for example, as an edge of the rotating cube transits the visual field. The energy model does not extract position to compute motion, rather, motion is treated as spatiotemporal orientation and the model consists of a network of "spatiotemporal filters" which respond to motion energy within particular spatiotemporal frequency bands. A network of these filters distributed across the visual field produces a net form of continuous output specifying the direction and velocity of motion of the edge.

The receptive fields of the energy model filters are inherently "apertures," and thus the velocities of the flow cannot be estimated with certainty due to the limited view of each field. More generally, this indicates that the visual system's measures of velocity are intrinsically uncertain, and thus the integration of a multitude of uncertain individual velocities must be inherently probabilistic. It is at this point of integration that the model of Weiss, Simoncelli, and Adelson (2002) inserts a fundamental, probabilistic (Bayesian) constraint. The constraint — in effect an invariance law — ultimately applied in mathematical form to the resolution of these velocities, is "motion is slow and smooth." The model explains a very large array of "illusions." In fact, due to this inherent measurement uncertainty, *all* perception, "veridical" or otherwise, the authors argue, must be viewed as an *optimal percept* based upon the best available information. Applied to the velocity fields defining a narrow rotating ellipse, for example, the violation of this "slow and smooth" constraint ends in specifying a non-rigid object if the motion is too fast (Mussati's illusion; Mussati, 1924). It is these constraints applied to the velocity flows, or their violation, that determine the rigidity of the form.

Were we to allow the coffee cup in our scene to be cubical and have it rotating, this form becomes a partitioned set of these velocity fields. As each side rotates into view, an expanding flow field is defined (Domini, Vuong, and Caudek, 2002). As the side rotates out of view, a contracting flow field is defined. The top of the cube is a radial flow field. The "edges" and "vertices" (i.e., "features") of this cube are now simply sharp discontinuities in, or junctures of, these flows. As we shall see below, and as the foregoing implies, the rigid form of the cubical cup is equally subject to a quite different "optimal specification" of its form.

Let us add just a little to our stirring event to draw the implications for that innocent form — the cubical cup. We'll place a cube made of wire edges near the coffee cup and set it rotating. This addition to the scene should be no problem

for our co-representational HOT that is about to make all this conscious. The cube has a symmetry period of four, being carried into itself every 90 degree turn. If we strobe this cube in phase with or at an integral multiple of the symmetry period, we will see a rigid cube in rotation near the cup. But if we strobe it out of phase, we now see a plastic, wobbly, non-rigid object (Shaw and McIntyre, 1974). The "features" of the cube — the nice straight edges and vertices and flat sides — have disappeared. Again, as we have already implicitly seen, time is all important in the brain's dynamics, and it appears this wobbly plastic-like cube is either a form of violation of the "motion is slow and smooth" constraint, or of yet another constraint used by the brain in the specification of form (e.g., a regular object exhibits a regular periodicity). To preview, we can already begin wondering how the "relation" between the ever-contorting, ever changing edges and their color can be specified in a HOT.

If the cup is static (it can never truly be so given the saccadic motion of the eye), and the spoon is stirring the coffee, a radial flow field is created over the liquid surface. Also, when we poured the coffee into the cup, the rate of increase of the pitch of the sound as the cup fills with liquid is an invariant coordinate with the visual rise of the liquid (Cabe and Pittenger, 2000).

Other Dynamics in the Event

The stirring motion of the hand is a complex of forces. The use of the spoon is a form of "wielding." This is described (cf. Turvey and Carello, 1995) under the concept of an "inertia tensor." A rigid object's moments of mass distribution constitute potentially relevant mechanical invariants since they specify the dynamics of the object. The object's mass is the zeroth moment, while the first (static) moment is mass times the distance between the point of rotation and the object's center of mass. The second moment is conceived as the object's resistance against angular acceleration. In three dimensions, this moment is a 3 x 3 matrix called the inertia tensor. The diagonal elements I_1, I_2, I_3, are eigenvalues and represent the object's resistance to angular acceleration with respect to a coordinate system of three principal axes (cf. Kingma, van de Langenberg, and Beek, 2004). There will be an inertia tensor (invariant), I_{ij}, specific to spoon-stirring.

Over the periodic motion of the stirring spoon, there is likewise a haptic flow field defined, and within this, there is an adiabatic invariant — a constant ratio of the energy of oscillation to the frequency of oscillation (Kugler and Turvey, 1987):

$$\frac{\text{Energy of oscillation}}{\text{Frequency of oscillation}} = k$$

This further relates to action. Over this flow field and its velocity vectors a value, τ, is defined by taking the ratio of the surface (or angular projection) of the field at the retina, r(t), to its velocity of expansion at the retina, v(t), and its time

derivative. This invariant, τ (or tau), specifies time to impending contact with an object or surface, and has a critical role in controlling action (Kim, Turvey, and Carrelo, 1993). A bird, for example, coming in for a landing, must use this τ value to slow down appropriately to land softly. As the coffee cup is moved over the table towards us, this value specifies severity of impending contact and provides information for modulating the hand to grasp the cup (Gray and Regan, 1999; Savelsbergh, Whiting, and Bootsma, 1991).

This is a mere beginning of what we can term the *invariance structure* of an event. The invariance structure of an event is a specification of the transformations and structural invariants defining an event and rendering it a virtual action. The transformations define the information specifying the form of the change — rotating, swirling, flowing. The structural invariants define the information specific to that undergoing the change — a cup, a liquid, a field of grass or gravel.

How Might a HOT "Conscious-ize" Coffee Stirring?

Rosenthal's theory of conscious unity, as Friesen noted, is sketchy: "Rosenthal has little to say about the precise nature of these higher-order representations" (2014, p. 211). Most of the imaginative work on "how things work" is a do-it-yourself project. If we go from the assumption that an event such as our coffee stirring is composed of various "sensations" in Rosenthal's terms, each of which appears to merit being called a "mental state," we bring ourselves concretely into what this co-representative HOT — a HOT that combines all these states — must actually be accomplishing.

So what states are we combining, and what is the form of the combination? As there is no *in principle* method of identifying states provided by Rosenthal, we are going to have to guess, but we will be far beyond settling for simple "relations" such as "cup at x, whiteness at x." We can start with the radial flow field of the liquid. The "thought" (HOT) must already be a constant, continuous, flowing "thought," as the stirring is an instance of "stream" unity in Friesen's terms, and the liquid is continuously moving, always in a changing configuration. The thought, "I am in this state (re the swirling)," must be constantly changing and doing so at a very fine scale of time, for the "state" is nothing but dynamic change. Is the thought, we might begin to ask, providing or supporting the perceived continuity of this change, i.e., the perceived swirl or flow? Is the "thought" being subtly substituted for a theory of the memory that supports this perceived flow over time, or simply riding upon this yet to be developed theory? The liquid itself must be precisely placed "within the cup" — it is just not "at place x" along with the cup. Further the form/appearance of the cup, as far as its inside upper sides, is constantly changing as the liquid sloshes a bit up and down the sides, so this movement of the liquid must be coordinate precisely with the cup's changing inside form, in a word, another thought — "I am in this state (re the cup holding

the sloshing liquid and its changing internal form/sides)" — that is constantly changing at a very fine scale of time.

As we are imagining our head move back and forth here, the constant size of the cup is a function of the invariant ratio of height to the texture density gradient of the table. The size of the cup on the retina is constantly changing, but the perceived size is not. This again is a function of a ratio held constant over continuous change. Is the thought then, "I am in this state (re constant cup size as my head moves forwards or backwards)"? But the constancy is relative to the texture gradient of the table top, for which we could also have the thought, "I am in this state (stretching surface of table)." The constancy of the cup, as a ratio of height to table texture units, is already a complex relation, i.e., an invariance within the totality of the scene over time — table gradient and cup — to which the brain must be responding. But then we should not need a "thought" to represent this relation between cup and surface. It is a relation intrinsic within the perceptual dynamics.

But this "redundancy" of a HOT, or perhaps better, lack of need for a HOT for combining "states" (which is to say the constantly changing aspects of the scene) emerges everywhere. That radial flow field of the liquid surface, remember, is being caused by our stirring hand. Thus we come to both the inertial tensor and to the adiabatic invariance — the ratio of energy to frequency carried over the periodicity of the spoon — that determines the actual form of the disturbance in the liquid, e.g., the velocity of the radial flow and other wave-aspects of the surface's disturbance, to include the degree of the liquid's sloshing down and up the cup's sides. But this felt mechanics, carried in a haptic flow, must correspond precisely with the liquid's motion, in fact it must do so, for it is at the root of this motion. If it did not correspond, we would detect it instantly as an anomaly, a detection that would be just as easily made, for example, if the periodic sound made by the spoon striking the insides of the cup is heard, rather than as a clinking, as a "snap, crackle, pop." There would be no need then, for a HOT to be co-representing, and doing so via some form of "relation," the precise fit of these supposedly disparate mental states — the motion of the liquid with the felt motion and dynamics of the spoon (to include the inertia tensor), or of this latter with the periodic "clinking" of the spoon. As noted, when the coffee was poured into its, say, tallish cup, the rising frequency of the sound as the coffee rose was coordinate with the visual velocity of the rise. This too would have been an amodal invariance available to the brain, spanning these two modes, making a "thought" relating the two "states" redundant at best, and at worst, as in all the above, strange to describe, e.g., "sound frequency increase (Δf) rising proportionally to visual height increase (Δh)," [and where we of course know what a "proportionality" thought is].

The nearby, strobed out-of-phase cube is rotating as a plastically changing, non-rigid, wobbly non-cube. For this wobbly non-cube, let us simply note that for this form — specified by the brain's dynamics and changing its shape constantly — the color patch that is coordinate with its wire-edges is also shifting/contorting precisely

with this changing spatial pattern. There is no conceivable co-representation relation embodied in a HOT that we could hatch up for this, short of that carried/specified in the brain dynamics itself. We are relying here on the global processing dynamics of the brain, just as we are relying on the adiabatic invariance carried over the haptic flows within this dynamics that must be coordinate with the visual motion and more. The usefulness of a HOT, or even how we would ever formulate the "co-representations" as anything other than the relations (invariants) enfolded within this very dynamics become increasingly questionable.

Stream Unity and Time

These elemental events — coffee stirring, a rotating cube — intrinsically require the stream unity noted by Friesen. We have the perception of continuous flow. I have argued elsewhere (Robbins, 2013) that there is no current theory of memory that can support this. If we have, for example, a theory that stores successive samples of the event in some memory, say an "iconic" store, we quickly hit an infinite regress. The samples are immobilities, like snapshots laid out on a desktop. Do we invoke an internal scanner to account for the motion? We begin the regress — we must explain the scanner's perception of motion. For the rotating cube, which, with an out-of-phase strobe (sample) rate, becomes a plastically changing not-cube, we have lost, furthermore, any foothold as to what such samples, in terms of their structure, could even be.

The sampling concept trades on the discrete state model of time, i.e., time (or events) as a series of static instants. If taken at the universal scale, it would be as though time is a series of 3-D instantaneous spatial blocks, each "block" comprising the entirety of space (the material universe) taken at the most infinitesimal duration, and each (present) block disappearing (going into non-existence, namely, into the past) as the next block (the "present") arrives. The brain, even in its dynamic change or processing, is simply a sub-block within the whole, universe-in-scale block of space, and integrally part of this discrete series of ever-renewed blocks. The coffee cup, table, and stirring spoon can be viewed also as a series of sub-blocks in the whole. The material realm, by this very definition of time, is comprised, at any one instant, entirely of the universal-in-scale, 3-D block of space, and there is — always, ever — only *one* such instantaneous, completely static, 3-D block (i.e., the "present" block). [One should wonder, is there not required some continuous process that generates each successive block?] Yet consciousness inherently demands continuity — it must span or cohere or bind at least two such instants or blocks, else we have the consciousness of a stone, i.e., instantaneity *without an iota of history*. So, to make the coffee stirring event conscious, Rosenthal is implicitly giving this binding power — the very creation of a dynamic flow or of a stream — to a HOT, i.e., to a thought.

So a thought would bind instants; it is responsible for the continuous flow, which is to say that it is binding successive states of the brain, i.e., successive

states of a chunk of the material world, together in a flow. In what realm — for, by the above definition, it is not the material realm, ever existing as it does only in one 3-D block or instant — do thoughts dwell such that they have this power? Is there but one continuous thought in this other realm, constantly modulating as events change? Or does a thought suddenly come into being to cover the coffee stirring, then another arise suddenly in this mysterious realm for getting up from the table and taking the toast out of the toaster? Or can a thought do just about anything HOT theory requires?[1]

On the other side of the coin, we see implicit appeals to continuity, as in the "continuity of neural processing," which use this surreptitious route to take care of the binding of (or memory of) instants problem, i.e., to ignore the implications of the discrete state model of time. Then we must be explicit as to the source of this continuity. Are we appealing, for example, to Bergson's (1896/1912) concept that motion must be viewed as *indivisible*, where there are no mutually external instants, where each of our instantaneous 3-D blocks of space (or instants) merges and interpenetrates the next, forming an organic continuity? But then we have a form of memory that is intrinsic to the very transformation of the material world, and then we would no longer need a thought (HOT) to undergird stream unity at all. The stirring spoon, or the fly buzzing by the coffee cup, or the brain's neural processing, are now sub-flows in the continuous, indivisible transformation of the universal material field. Then, remembering that there would-be no static, 3-D blocks instantly going into non-existence (the past) as the next arrives, the question would switch — it would move from wondering how a thought binds instants or how the brain uses a static memory store to store samples of an ongoing event. Using a Gibsonian term, the question would become how, eschewing any reliance on some regress-prone memory store, the brain "specifies" a past sub-flow within the transformation of the field (as we are always viewing the past) at a specific *scale* (something else a HOT must account for) — a buzzing fly, or a fly slowly flapping its wings like a heron, or a "fly" as a fuzzily outlined crystalline ensemble of whirling atoms.

These are questions for which Rosenthal is far from immune. They go to the heart of what a thought is. Admitting my lack of Rosenthalian expertise, certainly not at the level of Friesen's, my observation is that such questions on time are heavily neglected.

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[1]I am ignoring here the supposed space–time block of special relativity which comprises the entirety of past–present–future in a frozen 4-D structure, wherein no such instantaneous blocks of all of (present) space could exist. This is for at least two reasons: (1) this block model is itself a bad misinterpretation of the theory, and, (2) even were the block interpretation valid, no one can then explain our perceived flow of time and the experience of motion, save by hypotheses such as time-travelling fields of consciousness, themselves riddled with logical problems (cf. Robbins, 2014b).

Subject Unity, Explicit Memory and the Symbolic

Friesen demonstrates that the co-representation mechanism is insufficient to account for phenomenal unity, or event unity as we have treated things here, as there can be multiple mental states within an event, not all of which can be covered by this mechanism. To fill in the slack, Rosenthal relies on the indexical or "common ascription" mechanism, wherein all states are referenced as well to the self or "I." One of Friesen's criticisms of this common ascription mechanism is that it makes unity contingent on advanced mental abilities, for example, the capability of a certain kind of self-reference, the capacity to represent the contents of lower-order states in sufficient detail, and the ability to characterize those contents as contents of a mental state. The obvious problem, as he notes, is that phenomenal unity, which seems clearly present in very young children and animals cannot actually depend on the achievement of such abilities. This is certainly true, but Rosenthal's underestimate of the nature and source of his common ascription mechanism goes far deeper.

The "I" sense, therefore the indexical referencing, is at the very minimum highly correlated with "subject unity" in Friesen's list of unities, where events from our past are retrieved and related to one's present as part of our self-aware history. Weiskrantz (1997) termed this ability the "past x present" product. Friesen noted that there is a vast literature on the related ability to self-ascribe mental states. (This would include Block's [1995] notion of "access" consciousness.) I think it safe to say that the literature underestimates the nature and scope of what must be developmentally achieved. The retrieval of events from the past, with the awareness that the events were indeed experienced in our past, is firstly the great the problem of *explicit memory*. Piaget (1954) termed this ability, "the localization of events in time." In his description of its development, this ability is integrally related to the simultaneous emergence of a complex of concepts — Causality, Object, Space, and Time — a complex labeled COST (Robbins, 2009). It is a set of concepts that integrally support the emergence of the ability to symbolize. All in all, the organizational trajectory of the brain towards the eventual emergence of this complex requires roughly two years. It is an organizational achievement via the dynamic trajectory of what has been argued as the natural evolution of a dynamic system, where Piaget's "stages" are natural bifurcations along this path (van der Maas and Molenaar, 1992; Molenaar and Raijmakers, 2000). It is a trajectory leading to the brain's ability to assume a complex dynamic state, a state which allows the simultaneous relation of an event in the past to an event in the present, something I have termed an *articulated simultaneity*.

So, I am sitting on my porch, watching some waving wind chimes, simultaneously aware that I bought these chimes as a gift a year ago for my wife, or I am Piaget's 19-month old daughter, Jacqueline, who suddenly articulates, while looking at a piece of green grass, that this is (that it symbolizes) a "totelle" — the grasshopper (sauterelle)

her little brother played with the other day (Piaget, 1954, p. 391). In each case, this very "thought" correlating past and present and supposedly underlying this aspect of "subject unity" cannot even have come into existence — could not be supported — without the dynamic brain state supporting this past–present correlation. How, then, can a HOT (thought) be the causally efficacious instrument for this unified, past and present-relating consciousness, when the thought itself cannot come into being save for a dynamic that underlies this conscious, past–present correlation?

Higher Order Last Thoughts

As noted initially, Rosenthal makes it very clear that for him, all states, conscious and subconscious, are mental states and all mental states have a phenomenal aspect. While I find this assertion that "all is phenomenal" to be very problematic, Rosenthal admits that we must explain how these mental states gain their phenomenal aspect, but he throws up a roadblock to achieving an explanation.

> There is a second and I think better way to do justice to [phenomenal mental states]; we can do justice to them by explaining why it is we have those subjective appearances, and that's what we do with many other phenomena such as weight. We don't take our pre-theoretical conception of weight to be veridical, we explain why we have that pre-theoretical conception. We're going to have to explain why we have those subjective appearances, and supposing those subjective appearances are veridical isn't going to help us give such an explanation. (2012)

Yet we have seen that a perception theory based upon flows is not insisting on the "veridical," rather it is arguing that we always have an optimal specification of the external world. The non-rigid ellipse or the wobbly, plastic-like not-cube are optimal specifications. But note that these dynamically changing forms are themselves "qualia." The wobbly, elastically changing, sort-of-cube remarkably differs in quality from the rigid cube in rotation. Dynamically changing form as being itself, qualia — not just the "redness" or "blueness" of the rotating cube or of the wobbly cube — is exactly the intuition of Hardcastle as she enumerated her examples of qualia: ". . . the conductor waving her hands, the musicians concentrating, patrons shifting in their seats, and the curtains gently and ever-so-slightly waving" (1995, p. 1).

This, I should take a moment to note, brings us to the misleading confusion I fear is hiding in Rosenthal's "all is phenomenal" position. If all form is itself "qualia," then our image of the external world is entirely qualia — the kitchen, its table with coffee cup, the cup's whiteness, the spoon stirring, the curtains waving — and the question, rather than focusing on accounting for qualia, is then more general: it is the question of the origin of the image of the external world (Robbins, 2013). This image is that phenomenal experience that the hard problem in fact tasks us to explain. But then I can think of no subconscious

mental state that qualifies for the phenomenal in the same way as does our image of the external world. Seeking the explanation of both — subconscious mental states and the conscious perceived world — as the phenomenal in this sense, would be truly a misdirected effort.

In any case, while in this discussion of flowing events we have but briefly touched the question of the fundamental memory that underlies the perceived continuity of these changes (Robbins, 2004), and therefore underlying any supposed HOT as well, we are seeing a portion of the global dynamics of the brain — that portion responding to these flows — clearly involved in the specification of a qualitative form. Further, this portion must be integrally linked, via feedback loops, etc., to other coordinate aspects of the event. Imagine for example that the rotating cube is translating forwards or backwards across the table's texture gradient, while via the height to texture unit ratio, maintaining its perceived size constancy. Or imagine that it is our cubical cup that is rotating while our hand is stirring with a periodicity that is in phase with the rotation. Or imagine that while stirring, our hand itself is exerting a small force via the spoon to vector the (yet size constant) cup slowly towards us. Or, were the cup moving towards the cereal bowl, there is that tau ratio specifying severity of impending contact — again a complex relation defined over the flow. Is this complex tau relation not the actual relation required in yet another HOT ("The cup is about to smash into the bowl") purportedly needed for making this aspect of the scene conscious? This is simply to say that in these considerations of the brain's dynamics re flow fields, we are not only seeing the beginning basics of explanation of at least one very subjective experience, namely that of dynamic form, but simultaneously we are again seeing that many aspects of the event, if not all, must be naturally bound in this global state by coordinate information — something deeper than abstract, synchronous oscillations.

This principle of complex, coordinate information, I should note, simply reflects comments made earlier by Gibson (1966). He asked us to imagine a comb and taking our finger and running it down the comb's teeth. A rippling visual "wave" is created as each tooth is successively bent and snaps back, all coordinate with a series of staccato sounds, not to mention the haptic-embedded force and feeling as the finger passes down the line of teeth, and where each of these modalities is releasing information coordinate with the others and all certainly available with the global dynamics of the brain while responding to this event.

As we have seen here, in the subject of the unity of conscious experience, these dynamic structures of invariance, for which the study is in its infancy, are critical, and begin to give us glimpses into the basis by which the brain is tying it all together. What co-representational, relational HOTs would look like — given the relational information is in fact so dynamic and complex — other than these relations themselves as embodied in the brain's dynamics, becomes very problematic. It seems safe to say, as this understanding of the information in events progresses, that the notion of co-representational HOTs will become increasingly questionable.

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