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Time, Form and the Limits of Qualia

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Our understanding of qualia is extremely weak when considerations of time are brought into play. Ignored has been the fact that the scale of time imposed by the brain on the events of the matter-field already defines quality, and that there is an essential "primary memory" or continuity of time that underlies all qualitative events. This weakness is magnified when the concept of qualia is applied to form. The origin of the dilemma rests in the fact that the problem of qualia is posed in the context of an abstract space and time. When the time-evolution of the matter-field is taken as indivisible or non-differentiable, the problem can be reposed. It becomes a problem of the optimal specification of properties of an already qualitative matter-field at a particular scale of time.

Keywords: qualia, dynamic form, time

The concept of qualia has assumed an extremely dominant position in discussions on the nature and origin of consciousness, perhaps, picking an arbitrary date, ever since the exposition of the hard problem by Chalmers (1995). But this concept, for having such a crucial role, is strangely undefined, perhaps even unanalyzed. The essence of the analytical neglect has been in the dimension of time. Two critical things have been ignored: (1) the scale of time imposed by the brain on the events of the matter-field already defines quality; (2) an essential "primary memory" or continuity of time that underlies all qualitative events, i.e., that underlies all qualia, whether it be "singing" violin notes, or "buzzing" flies. The origin and nature of this must be explained. In fact, I (Robbins, 2004a) have argued, this latter problem has primacy over the problem of qualia.

Within this, the implications of the problem of form have been neglected. Form itself receives no mention in the numerous exemplar definitions of

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qualia. Yet when taken in its dynamic aspect — "rotating" cubes, "twisting" leaves, "buzzing" flies — every experience of form has a scale of time and an extent of time, therefore being instantly subsumed in (1) and (2) above, and makes a powerful demand for the expansion of the qualia notion beyond its current, vague limits, though if I would be more precise, I should say the question of form reduces qualia, in its current construal, to a very questionable status.

What are "Qualia"?

In the realm of definitional attempts, Dennett (1991) set forth his four criteria for qualia — ineffable, intrinsic, private, directly apprehensible. Lewis (1929/1991) is generally credited with starting the ball rolling with his definition of qualia as "recognizable qualitative characters of the given," while Nagel (1974) coined the now-frequently employed "what it is like" formulation. But in the course of searching for definitions of qualia, one is struck by the preponderance of simple, static illustrations: "the redness of red," "the way the sunset looks to you," "the taste of milk or the taste of cauliflower." Hardcastle (1995, p. 1) describes things with hints of the dynamic: "I go to the symphony . . . I see the conductor waving her hands, the musicians concentrating, patrons shifting in their seats, and the curtains gently and ever-so-slightly waving." But the hint of time here is never followed, in fact is dismissed as a problem for her subsequent analysis.

Perhaps it is closer to the state of affairs to view qualia as being defined in a subtractive approach (cf. Goguen, 2004). For a musical phrase, the approach would be to bracket or isolate the qualitative aspects and focus on (objective) aspects reducible to scientific analysis, e.g., the duration in milliseconds, intensity in decibels, spectral analysis of timbres. The residue, namely everything not quantitatively described, are now designated qualia. For form, presumably, focus would be on lengths, angles, ratios, geometric relations. In all, qualia are the remainder after intentionality is subtracted. The nearly unavoidable tendency of this approach, as Goguen notes, is to reify qualia with an independent existence as Platonic entities, simultaneously introducing an ontological distinction between objective and subjective aspects of experience. The essence of the hard problem is in reconciling these two, apparently irreducible spheres — the qualitative/subjective vs. the scientific/objective.

Goguen (2004) notes that qualia are often taken, as it were, as atomic, i.e., non-reducible, without constituent parts. The implicit belief, he notes, seems to be that qualia are atoms, completely independent of perception and cognition, which somehow combine to form molecules of experience. Perhaps paradigmatic here, Hameroff and Penrose (1996) envision qualia existing independently in the "geometry" of space-time. Qualia exist as well in microtubules in the brain, just waiting to be configured to look like correspondent external space-time qualia configurations. It is hard to miss the atom-like implications here.

Time, Form, and Qualia

Let us do an exercise. Let us imagine the world has only one color quale — gray. In this gray world, we have a gray cube rotating. We see the four corners or edges in circular motion. The cube has a symmetry period of four, being carried into itself every 90 degrees. Gradually speed up the rotation. The four corners/edges begin to "serrate" into yet more corners, and the cube becomes a sort of cylinder surrounded by fuzzy, serrated edges. As the rotation speed increases, the number of serrations increases ($4 \rightarrow 8 \rightarrow 12 \rightarrow 16 \ldots$, etc.), i.e., becoming figures of 4n-fold symmetry, with n increasing. A little more speed — a fuzzy cylinder with yet more serrated edges. More speed — a perfect cylinder with fuzzy haze surrounding it — a figure of infinite symmetry. This is, undeniably, a qualitative transition. Each of these transitional forms is a different quality, and the transition itself has a quality. We have a single color quale (gray) world here, yet with rich qualitative aspects due to dynamic form.

By the logic of qualia, we therefore need "form qualia." If we employ the "qualia-as-atoms" mindset, we can ask what form qualia could be? What could such qualia look like other than the forms themselves?! But now we have reduced the concept of qualia, as least in its "atom-like" construal, to an absurdity — at best a tautology. And now we are in the questionable position of describing form qualia.

Let us extend the reasons for the difficulty. Each of the transitional forms — rotating cube, serrated-edged cylinder, fuzzy cylinder — is reflective of our scale of time. This scale is a function of the brain's dynamics and of its energy state/chemical velocities. Gradually speed up the chemical velocities underlying the brain's computations: if we start with a cube rotating at such a velocity that it is perceived as a cylinder surrounded by a fuzzy haze, then as the chemical velocities increase, we should obtain the inverse of the series described above. The fuzzy-hazed cylinder we are perceiving gradually transitions through serrated-edge figures of successively lower 4n-fold symmetry, and on finally to a slowly rotating cube. Were a fly buzzing by during this transitional increase in chemical velocities, its wings initially a-blur at 200 cycles/second, the perceived wing beats would gradually slow, becoming more distinct, perhaps resulting in a "heron-like" fly moving by, slowly flapping his wings.

Form, then, is a function of the scale of time. So, in the qualia-as-atoms mindset, now our form qualia must be specific to a scale of time. Would such qualia exist for every possible scale? But this leads to more difficulties of the concept of qualia. Current perception theory sees perceived form as derived from velocity fields (see Figure 1) in conjunction with Bayesian constraints.

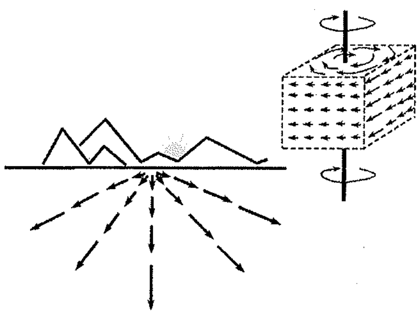

Figure 1: Optical flow fields. A gradient of velocity vectors is created as an observer moves towards the mountains. The flow field "expands" as the observer moves. At right, the expanding flow as a side of a cube rotates towards the observer.

The models (known as "energy" models) are built upon arrays of elementary spatiotemporal filters, and such filters, because of their limited receptive fields, are subject to the aperture problem.[1] As such, the estimate of velocities is inherently uncertain, forcing a probabilistic approach (cf. Robbins, 2004a, for a review). The fundamental (Bayesian) constraint used by Weiss, Simoncelli, and Adelson (2002) is "motion is slow and smooth." The constraint explains numerous "illusions." Applied to the velocity fields defining a narrow, rotating ellipse, for example, the violation of this constraint ends in specifying a non-rigid object if the motion is too fast (Mussati's [1924] illusion). In this context, if we were to consider a "Gibsonian" cube, this becomes a partitioned set of these velocity fields. As each side rotates into view, an expanding flow field is defined. 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" of this cube are now simply sharp discontinuities in these flows.

All form, then, from the energy model perspective, is an optimal specification given the inherent uncertainty of information. When a rotating wire cube is strobed in phase with its symmetry period or at an integral multiple, it is perceived as a rigid cube in rotation (Shaw and McIntyre, 1974). But when strobed out-of-phase, apparently breaking a certain temporal symmetry constraint that the perceptual system employs for form, what is perceived is a wobbly, plastic object (see Figure 2). It has no rigidity, no straight edges, no

[1]Imagine a white playing card which has a grating or series of diagonally slanted black lines spaced across its surface. The card is moving directly to the right and the passing lines are seen only in the window of a circular aperture. The ends of the moving lines are now obscured by the border of the aperture. Only the downward motion of the lines is seen. The component of velocity moving to the right is not seen, rather, only the component of the velocity orthogonal to or normal to the lines — this component is moving downwards. Hence the true velocity of the lines cannot be determined.

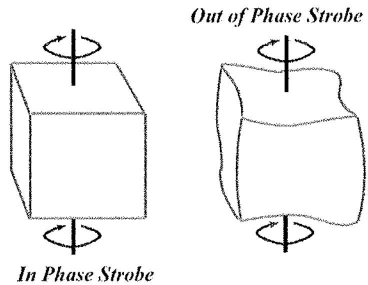

Figure 2: Rotating cubes, strobed in phase with, or out of phase with, the symmetry period. Reprinted from S.E. Robbins, On time, memory and dynamic form, *Consciousness and Cognition*, 7, p. 769, ©2004 with permission from Elsevier.

vertices. We have yet another new qualitative experience for "cubes." Again, considering any qualia-as-atoms mindset, we would wonder where the form qualia for this come from.

The strobe is essentially taking snapshots of the cube. Yet the snapshots are not sufficient to specify the rigid cubical form we would expect. They are not sufficient to specify the straight lines, straight edges, corners or vertices — the standard static, geometric "features" of a cube. The strobe occurs over time. There is something about the brain that makes even form a function of time.

If we take the subtractive approach to the definition of qualia, form, as generally is the case, apparently does not make it to the usual exemplars of qualia because the standard geometric quantities — lines, edges — seem so simply computable. Disconcertingly, these have disappeared. As Gibson (1966, 1979) long argued, the concepts of our Euclidean geometry — straight lines, curves, vertices, sets or families of forms related by geometrical transformations, even geons — while elegant, may have little meaning to the brain, i.e., they are not the elements by which the brain constructs a world. A "constraint" applied to velocity fields is simply another word for an invariance law. The series — rotating cube → figures of increasing serrated edges → fuzzy cylinder — expresses an invariance law defining figures of 4n-fold symmetry. The forms being specified are functions of the application of constraints on flowing fields. The structure of the forms reflects invariants existing over these time-extended flows. The "ineffable" of form is this: invariance over the time-extended, flowing field.[2]

One cannot have perceived invariance over a flow without simultaneously perceiving the flow. Thus we have initially arrived at the reason that the "pri-

[2]For the fundamental role of invariance laws in scientific explanation: in physics, see Wigner (1970); in perception/action, Kugler and Turvey (1987); in biology, Woodward (2000, 2001).

mary memory" that supports the perception of rotating cubes, i.e., all time-extended perceived events, has primacy over the problem of qualia.

Qualia and Primary Memory

The question of the "memory" supporting the qualia of dynamic form is all important. Some form of primary memory is required to support the experience of rotating cubes or buzzing flies. I am appropriating the term primary memory here. I mean a form of memory even more fundamental than the sense in which James (1890) used the term. The question is critical. In fact, the question has primacy over that of qualia. No qualia can exist without some extension in time. The problem is the origin of this extension.

It is a natural theoretical tendency to model this in terms of samples or snapshots of the event, where the snapshots are stored in a short-term or immediate memory medium, or iconic store, etc., allowing the motion to be reconstructed. The event of the rotating cube would be parsed into a series of slices, each consisting of a frozen, static snapshot comprised of the static features of the cube — its edges, vertices, surfaces — at some position along the imagined circle of the rotation.

The sampling model of the memory supporting the perceived event is inherently flawed. Each sample is only a static state. A series of such states is simply a series of static states, as though we have laid out a row of snapshots of the event upon a desktop. We have lost the motion. If we introduce some sort of "scanner" within the brain to scan the stored samples, then we must explain how the scanner perceives motion. We begin an infinite regress.

There are other, practical difficulties. For Shaw and McIntyre's wobbly non-cube, the strobe flash is equivalent to a sample. Thus, a brain-driven sampling mechanism, to allow the specification of a cube-in-rotation, would have to be pre-adjusted to the symmetry period of the cube. This would require a form of pre-cognition. And what if there were two or more cubes rotating at different rates? Further, implied within each sample is a set of static features — edges, vertices, rigid sides. These, however, are only ephemeral constructs to the brain — sharp discontinuities in velocity fields. In the global specification of the form, they are functions of Bayesian constraints. Destroy or change these constraints, the "features" disappear.

If we abandon sampling, we can always simply invoke the "continuity of neural processes." Taylor (2002), for example, visualizes neural activity loops, wherein ". . . neural activity "relaxes" to a temporally stable state, therefore providing the extended temporal duration of activity necessary for consciousness" (Taylor, 2002, p. 11). But what allows us to grant this temporal extension to the brain? What would be its limit? A minute? Our entire lifetime? The entire history of the matter-field? Such an extension, whatever its limit, conflicts completely with our model of matter, tied as this is to the classical model of time, for in this, matter exists only in the "present" instant. The past, to us, is the symbol of *non-existence*. As a buzzing fly makes each wing beat, the previous wing beat moves into the past. Unless it has been stored in the ever "present" brain, that is, in matter, the previous wing beat is lost. The perception of the buzzing fly consists of a long series of these once-present instants that have long since come and gone — unless somehow stored in the present brain.

If the time-extent of the present, and of the matter-field that exists only in the present, is only an instant, what is the extent of this instant? In fact, the classical instant is infinitely divisible. The end of an infinite operation of division is at best an abstract mathematical point. This is all we are allowed to say for the actual time-extent of the neurological processes.

I must insist on a decision here. If our model of time is a series of instants, and the time-extent of each is "infinitesimal," we must store each instant, instantaneously, in the brain. For the rotating cube, this necessarily translates into a set of stored, instantaneous snapshots. From this we must reconstruct the cube's motion. Simultaneously, it goes without saying that the notion of "time-extended" neurological processes is a convenient, but invalid myth, and that the time-extension of these processes cannot be invoked to support the perception of something even so simple as a rotating cube.[3] So let me return to the question: How can we support the time-extent of perceptual events — rotating cubes, singing violins, buzzing flies?

Abstract Space and Time

If we are Hameroff and Penrose, we are positing disembodied, abstract "qualia" as ghostly inhabitants, with no explainable time-extent, of the space-time continuum. The concept of the continuum is itself the problem. It is the essence of an *abstract* space and time.

Abstract space, Bergson (1912) argued, is derived from the world of separate "objects" gradually identified by our perception. The body is surrounded by a continuous, extensive, dynamic field. Our perception must partition the field into objects upon which the body can *act* — to throw a "baseball," to lift a "glass of wine," to grasp a "cube" which is "rotating." It is an elementary partition of "objects" and "motions" tied to a particular scale of time. It is further rarified. The separate objects in the field transition to the notion of the con-

[3] I have neglected what some might believe to be relevant — the four-dimensional implications of relativistic space-time. A detailed treatment would require a long digression (cf. Robbins, 2005). The short answer is that the theory is not relevant. Rakić (1997), in proving certain logical inadequacies of the Minkowski metric, is reduced to declaring special relativity to be not an ontological theory, but concedes it a status as a "temporal" theory. Whatever meaning this concession might have, a theory with no ontological status is not relevant to psychology.

tinuum of points or positions. A fly moving across the continuum, say, from point A to point B across a table, is conceived to describe a *trajectory* — a line — consisting of the points or positions the fly traverses. Each point momentarily occupied is conceived to correspond to an "instant" of time. This series of instants gives birth to an abstract time — itself simply another dimension of the abstract space. This space, argued Bergson, is in essence a "principle of infinite divisibility." Having convinced ourselves that this motion is adequately described by the line/trajectory the object traversed, we can break up the line (space) into as many points as we please. But this is inherently an infinite regress. As with the samples of the rotating cube, to account for the motion, we must, between each pair of static points/positions supposedly occupied by the object, re-introduce the motion, hence a new (smaller) trajectory of static points — ad infinitum.

The paradoxes of Zeno, Bergson held, were Zeno's attempts to force recognition of the logical implications of this infinitely divisible, abstract space and time. With each step, Achilles halves the distance between himself and the hare, but he never catches the hare; there is always a distance, no matter how minute, between pursuer and pursued. In the paradox of the arrow, the flying arrow occupies, at each instant, a static point in space, therefore, "it never moves." In all four of the paradoxes, it is the infinitely divisible space traversed which is the focus. Motion, Bergson argued, must be treated as *indivisible*. We view the indivisible steps of Achilles through the lens of the abstract space traversed, and then propose that each such distance can be successively halved — infinitely divided. Achilles, never reaches the hare. But Achilles moves in an indivisible motion; he indeed catches the hare.[4]

I have argued, then, that neural processes have no time-extent, that it is not possible to appeal to such a time-extent without implicitly violating the logic of the model by which we store experience in the brain in the first place.[5] In effect, this argument is also to force Zeno's point. The classical abstraction — matter/time as a series of instants — forces us to clarify our concept of matter. The "instants" commit us to the principle of infinite divisibility — abstract space — and the ultimate endpoint of this division in the

[4]There is a mythology that these paradoxes have been resolved by Russell (1903) and/or modern mathematics. While Bergson showed that all four paradoxes have exactly the same root cause in an abstract space, Russell, having missed the point, actually accepted the fourth paradox as a physical reality. The mathematical "resolutions" are inherently limited to a spatial treatment and, in "taking a limit," simultaneously invoke hand waving over infinity in the operation (cf. Bergson, 1907/1944, pp. 335–340).

[5]I am not saying that the neural structure is not capable of modification, as per the connectionist net, and thus capable of storing memory in this form, e.g., a form of "procedural" memory. This is far different from storing "experience." For one thing, we do not yet know what "experience" (perception) is, and if, as I shall later argue, it is not solely occurring within the brain, it certainly cannot be solely stored there (cf. Robbins, 2006).

abstract mathematical point. At such a point, there is no time. This is the inherent extent of the instant, the time-extent of matter, the time-extent of the brain, and the time-extent of all neural processes. If we hold to the classical abstraction, it is on this logical and metaphysical basis that we must explain the perception of rotating cubes, buzzing flies and the singing notes of violins, that is, all qualia.

Abstract space and time is a "projection frame" for our thought. It is derived from the necessity for practical action, itself derived from perception, ironically, the very thing we are trying to explain. Re-imported into the problem of conscious perception, it is a barrier. Physics itself has struggled to break from this projection frame. For Bergson, ". . . *a theory of matter is an attempt to find the reality hidden beneath . . . customary images which are entirely relative to our needs* . . ." (Bergson, 1896/1912, p. 254, emphasis added). For physics, the "customary images" of the abstraction have been the ultimate barrier.

Physics and the Abstraction

What is a "particle," Bergson asked, but the extension in thought of this bodily perceptual process by which useful objects were first identified in the whole. It is a concept derived purely for practical action which will never, imported into the realm of pure knowledge, explain the properties of matter.

> But the materiality of the atom dissolves more and more under the eyes of the physicist. We have no reason for instance, for representing the atom to ourselves as a solid, rather than as a liquid or gaseous, nor for picturing the reciprocal action of atoms by shocks rather than in any other way. Why do you think of a solid atom, and why of shocks? Because solids, being the bodies on which we clearly have the most hold, are those which interest us most in our relations with the external world . . . . (1896/1912, p. 263)

Thus, from a population of theoretical particles — muons, gluons, leptons — physics eventually moved to quarks. But the quarks, with their various spin states, became ever less material, and we are asked to abstract from the spin state of a quark all mass, leaving an abstract mathematical point with its value of spin. Below this now are postulated the strings, inconceivably small violin strings as it were, whose harmonics give rise to the whole of the field of matter. And thus, in the end, contemplating the dynamic movement of this field: ". . . they show us, pervading concrete extensity, modifications, perturbations, changes of tension or of energy, and nothing else" (Bergson, 1896/1912, p. 266).

Simultaneously, the concept of a *trajectory* of a moving object also faded. In quantum mechanics, one can determine through a series of measurements only a series of instantaneous positions, while simultaneously renouncing all grasp of the object's state of motion, i.e., Heisenberg's principle of uncertainty. The measurement, de Broglie (1947/1969) noted, is in essence projecting the motion to a point in our continuum — we have lost the motion. Over forty years before Heisenberg, Bergson argued, "In space, there are only parts of space and at whatever point one considers the moving object, one will obtain only a position" (Bergson, 1889, p. 111).

Nottale (1996) argues that we should reject the long held notion that space-time is differentiable, pointing out the proof by Feynman and Hibbs (1965) that the motion of a particle is continuous but not differentiable. He adopts a fractal approach — indivisible elements which build patterns. To differentiate is to divide into ever smaller parts or divisions, be it the slope of a triangle or a motion from A to B. The divisions can be infinite in number, infinitely small, and when these have become so minute, we "take the limit" of the operation — obtaining the measure of say, "instantaneous" velocity, or slope, etc. To say "non-differentiability" is to say — "non-infinite divisibility." We have something — indivisible. Equivalently, we may say the global evolution of the matter-field cannot be treated as an infinitely divisible series of states; it is non-differentiable.

Lynds (2003), echoing Bergson, argues that there is no static instant in time underlying a dynamical physical process. Such an instant would imply a momentarily static universe. As such, motion and variation in all physical magnitudes would be impossible, as these magnitudes would be frozen at that precise instant, and remain that way. It would be a universe incapable of change, unable therefore to assume another static instant. At no time, then, is the position of a body (or edge, vertex, feature, etc.) or a physical magnitude precisely determined in an interval, no matter how small, as at no time is it not constantly changing and undetermined. It is a necessary tradeoff — precisely determined values for continuity through time. As Lynds argues, it is only the human observer (mentally immersed in the abstract space) who imposes a precise instant in time upon a physical process. There is no wave equation, no equation of motion, no equation of physics that is not subject to this indeterminacy.

Precisely because this static instant does not exist, there can be no static form. The brain is equally embedded in the transforming matter-field, i.e., it is equally a part of this indeterminacy. It cannot base its "computations" on something that, to it, does not exist. It can only be responding to invariance over change.

The Abstraction and Quality

But the abstract space is further refined. We can move the object across the continuum, or the continuum beneath the object. Motion now becomes *immobility* dependent purely on perspective. Motion is *relative*. All *real*, concrete motion of the matter-field is now lost. All quality therefore is lost as well. A continuum of abstract objects in abstract motions — motions that can supposedly can become rest dependent upon the perspective (or state of motion or rest) of an observer, and which are described as a series of instantaneous points — cannot support quality. Quality demands a far different conception of time.

Consider the concept of "mellow." The word has manifold meanings: we can talk of a wine being mellowed with age, a dimension of the word we apply to taste. We speak of a violin being mellow or of a song being mellow, a dimension applying to sound as well as mood. We speak of the interior of a house or room being mellow, referring to the visual. We can say mellow of a soil. The concept of mellow expresses a very abstract qualitative invariance defined *across* many modalities. At the same time *within* each of these dimensions it is a quality that emerges only over *time*, within the experience of a being dynamically flowing over time. Mellowness does not exist in the instantaneous instant. This quality can only become experience for a being for whom each state is the sum and reflection of the preceding states, as a note in a melody is the reflection of all those preceding it, a being whose states in fact permeate and interpenetrate one another. If we take this to heart, we should say that the meaning of the word mellow is an invariant defined within and across modalities and over time. It is not a homogeneously represented invariant, nor can it exist in space, when space is defined as the abstract, three-dimensional, instantaneous cross-section of time.

Trees grow. Organisms age and die. Planets are born. Stars explode. There must be *real* motion. Bergson would insist:

> Though we are free to attribute rest or motion to any material point taken by itself, it is nonetheless true that the aspect of the material universe changes, that the internal configuration of every real system varies, and that here we have no longer the choice between mobility and rest. Movement, whatever its inner nature, becomes an indisputable reality. We may not be able to say what parts of the whole are in motion, motion there is in the whole nonetheless. (1896/1912, p. 255)

He would go on to note:

> Of what object, externally perceived, can it be said that it moves, of what other that it remains motionless? To put such a question is to admit the discontinuity established by common sense between objects independent of each other, having each its individuality, comparable to kinds of persons, is a valid distinction. For on the contrary hypothesis, the question would no longer be how are produced in given parts of matter changes of position, but how is effected in the whole a change of aspect. (1896/1912, p. 259)

The motions of objects are seen as changes or *transferences of state*. The motion of this whole, this kaleidoscope as Bergson called it, is best treated in terms of a melody, the notes (states) of which permeate and interpenetrate each other, the current note being a reflection of the previous notes of the series, all forming an organic continuity, a succession without distinction (Bergson, 1889, pp. 100–101), a motion which is indivisible. Such a global, melodic motion of the matter-field can support quality.

Quality and Scale

Scale implies quality. Understanding this is essential in the approach to the problem of qualia. As the cube transitions, we are not only changing its numerousity in symmetry, but also its qualitative form. The heron-like fly is a far different quality then the buzzing fly. Were the cube a color of red, a color comprising some 400 billion oscillations of an electro-magnetic field over the short period of a second, the quality of this color would change, becoming more vibrant as we approached the scale of the heron-like fly. Were we to take the transformation of the cube even further, revealing its molecular depths, the lowly static cube would be seen in a qualitatively different aspect.

Scale and quality can be equated only when the framework is abandoned (or at least placed in the proper perspective) wherein matter consists of objects in motion, be these objects particles or electrons or quarks, etc. A field of abstract, homogeneous objects, in equally abstract motions, introduces an impassable gap between these objects/motions and quality (or qualia). The process by which these objects/motions are translated into sensations remains ever a mystery — we have motions, or rather changes of position in space, on the one hand, and conscious sensations on the other, with no means of transition or union. If the matter-field is modeled as a globally transforming whole, where the motions of objects are transferences of state, we have the basis for this union. *Real* motion becomes quality itself. At the null scale of time, this may be near the homogeneous state envisioned by classical mechanics in its particles with their abstract motions. But as we impose scale, this changes:

> May we not conceive, for instance, that the irreducibility of two perceived colors is due mainly to the narrow duration into which are contracted the billions of vibrations which they execute in one of our moments? If we could stretch out this duration, that is to say, live it a slower rhythm, should we not, as the rhythm slowed down, see these colors pale and lengthen into successive impressions, still colored no doubt, but nearer and nearer to coincidence with pure vibrations? (Bergson, 1896/1912, p. 268)

The matter-field is intrinsically qualitative, and the specification of scale is the underpinning of perceived qualia. In fact, we can propose: quality is a specification of scale upon the matter-field taken over a time-extent of the field's non-differentiable motion.

Color can now be construed as a property of the matter-field, or more precisely, as an optimal specification of color properties within the field. Dynamic form can be construed as a property of the field, or more precisely, an optimal specification of properties of the field. The indivisible, or non-differentiable motion of the field supports the experience of rotating cubes, singing violins. Each instant of the cube's rotation does not cease to exist unless stored within the (always present) brain.

The Coding Problem and the External Image

The problem of the origin of external *image* of the rotating cube is clearly an intrinsic aspect of the problem of qualia. Let me review the problem. In this, there is perhaps no more stark and concise a painting than that of Crooks's (2002) verbal-diagrammatic presentation. Crooks pictured a square and a circle a short distance from one another. Arrows or rays/lines are proceeding from the surface of the square towards the circle. The square represents an external object (or distal stimulus), the circle is the brain, and the arrows represent the light rays reflecting from the object to the brain (or proximal stimulus). This is perception from a scientist's eye view. The rays continue through the retina, the photic energy is transduced and encoded within the central nervous system (CNS) of the observer perceiving the square into a neurally-based representation of the object. As Crooks notes, the processing of the physical energy ends in the relevant sensory cortex. *There is no backward projection, there is no return of vision to the square.* All perception then, even though of an *external* object, is occurring within the CNS. This, he states, is the undeniable finding of neuroscience.

The paradox is clear: we cannot actually see into physical space or directly observe the distal stimulus, yet our experience, our everyday phenomenology, is that of actually doing so. The object appears located externally to the brain, in depth, in volume, in space. It is a disturbing, counterintuitive paradox, as Crooks notes. We are virtually wired to believe otherwise, to hold that perception is direct. But Crooks's sparse picture (the square, the circle and the arrows) stands in eloquent contradiction.

Though this picture, per Crooks, is the undeniable finding of science, science has no theory today on how the *image* of the square, external, in depth, arises from the processes within the circle. The essence of the dilemma can be termed the coding problem (cf. Bickhard, 2000; Bickhard and Ritchie, 1983; Robbins, 1976). What is the coding problem? The light patterns or sound patterns of the external matter-field are being translated to the brain's own form of code. The external world is encoded in the form of neural firing patterns. I am picking neural as a level here, but this could be quantum states, resonating water molecules, chemical flows, or, if considering a computer, 0/1 bit patterns, on/off states of electromagnetic cores, etc. This encoding resides in the strange, dark, internal world of the brain. How, we ask, can a code, which is supposed to stand in for something known, i.e., for the external world, be itself the means by which the external world is known? Three dots, ". . ." (a code), encoded in your neural matrix so to speak, can stand for an "S" in Morse code, the number 3, the three blind mice, or Da Vinci's nose. How is the domain of the mapping specified? How is a code unfolded as the external world without already knowing what the external world looks like? This is the coding problem — it is the problem of representation in its most essential form.

Chalmers (1995) famously framed the problem as the hard problem. How, after describing your neural firing patterns, or your changing bit patterns, or your functional architecture, or whatever model you are building, do you account for qualia — the look and feel of the external world? How, when all is said and done, do white, steaming coffee cups arise, or the singing sounds of a violin spring forth from some data processing architecture (which all rests on changing patterns of bits) or from some neural net architecture (with its firing patterns) which you are perhaps describing?

Theorists of consciousness have tended to emphasize this qualia formulation of the problem. One seldom if ever sees the problem discussed in terms of accounting for the external image. But when the hard problem is phrased exclusively as "trying to account for the qualitative feel of the world," we unfortunately disguise the coding problem which constitutes a major dimension of this difficulty. The problem of the origin of the external image has been the subject of the theory of perception for over 2000 years, starting with the Greeks (cf. Lombardo, 1987, for an historical overview). Its submergence under the question of qualia, while emphasizing an aspect of the problem of the external image, has been perhaps to our detriment. It is the *image* of the external world we are trying to account for. It is the image that has time scale and extent. The image, we feel, is somehow coded in the neural flows of the brain. How is the code unfolded as the image of the external world — the rotating cube or the steaming coffee cup with liquid surface swirling while being stirred?

Innumerable theorists have claimed to solve the hard problem while failing to recognize the coding problem untouched at the core of their theory. We cannot take the neural-encoded information, apply an "integrating" magnetic field (e.g., McFadden, 2002), and claim we have explained the image of the coffee-cup-being-stirred when we cannot explain how this integration unfolds the code. We cannot expect a higher order thought or concept (Gennaro, 2005; Rosenthal, 2002) to unfold the neural code as the external image, to include its scale of time and time-extent, without a theory as to how a "thought" could possibly do this. If we fall back and say a higher order thought is only that which makes the "contents" of consciousness conscious, and have no theory as to how the neural code is unpacked as "content," i.e., the image, we admit that higher order thought cannot solve the hard problem. We cannot expect RoboMary (Dennett, 2005), a theoretical robot who does not perceive color, to overcome this lack simply by self-programming the range of color codes in her color registers. Dennett simply ignores the coding problem. We cannot encode the world holographically within the brain, in neural holoscapes, as Pribram (1971, 1991) proposed, and think we have solved the problem when we cannot explain how holographic neural processes now unfold the coded information as an external image. We cannot simply invoke panpsychism and think we have solved the coding problem. We cannot invoke quantum microtubules (Hameroff and Penrose, 1996) or any form of quantum process such as objective reduction when such a process has no facilities to solve the coding problem.

The external image is indeed qualitative, but we cannot ignore the fact that we must account for the image itself as well as the fact that it is intrinsically qualitative. Let me sketch a way of resolving both questions within the non-differentiable motion of a qualitative matter-field.

Direct Specification of a Qualitative Field

I have been using the Gibsonian term, "specification," and have a very concrete construal of this term in mind which has been discussed elsewhere (Robbins, 2000, 2001, 2002, 2004a, 2004b) and which I wish to sketch here, as its very possibility casts additional light, I believe, on the problem and nature of qualia. Crooks's problem is understated — the static square of his hypothetical figure should be in motion, for example, rotating. Not only does the rotating square appear to be external, but (a) it appears "present" when its rotations are undeniably in the *past*, and (b) a time-extent of this rotation is perceived. But if we conceive of the time-evolution of the matter-field as non-differentiable, it allows us to construe "specification" as specification of a portion of the *past* motion of the field. We do not need to understand how slices or samples of an event are stored in short term or intermediate storage areas of the brain. We do not need a scanner to reintroduce the motion of the event, and the logical problems this brings. The "specification" supported by the brain's dynamics is necessarily to the *past*, i.e., to past "states" of the transforming matter-field. The external events the brain is processing — the wing-beats of the fly, the motion-cycles of the cube, and all the micro-events comprising these motions — have long since come and gone. Yet the non-differentiable or melodic motion of the field, the fictional status of present instants that cease instantly to exist — tell us that this past-specification is possible.

The coding problem can be seen more clearly if we consider an approach that is based in an actual physical process that unfolds a code, and inherently involves specification. The essence, in the abstract, comes down to this: we must cease viewing the world as being encoded or represented within the brain; rather, we must see the brain as itself the decoder. The concrete example of this, despite the mini-critique of Pribram above, resides in holography.

Technically, we know that a hologram is the recorded interference pattern of two waves (cf. Kock, 1969). The *reference* wave is usually emitted from a source of coherent light such as a laser. The *object* wave arises from light reflected from the object, say our cube, for which we intend to make a hologram. The object wave is complex. Each point of the cube can be visualized as giving rise to a spherical wave, spreading towards and over the plate. The information for each point is thus spread across the entire hologram plate. Conversely, then, the information for the entire cube is found at any point of the hologram — each point reflects or carries information for the whole. Any portion of the hologram is thus sufficient to reconstruct the image of the entire object. The plate is the recording/encoding of this complex interference pattern (where crest meets crest, or crest meets trough, etc.). It is itself a complex code. The interference pattern looks nothing like the original object.

Figure 3 (left side) shows the process of image, or more precisely, wave front reconstruction. A reconstructive wave — a wave with the same frequency as the original reference wave — is beamed through the hologram plate. The wave is diffracted (as waves of water passing through and around barriers in a harbor) as it passes through the interference fringes recorded on the plate. A viewer, placed in the path of the upward traveling wave set, believes herself to see the source of the original wave set located behind the hologram plate, in depth, in volume. This wave set specifies what is termed the "virtual image."

For a series of n wave fronts (events) wi, each wave front can be stored using a different reference wave frequency, f_i. If a reconstructive wave is successively modulated to each precise frequency, each wave front is successively

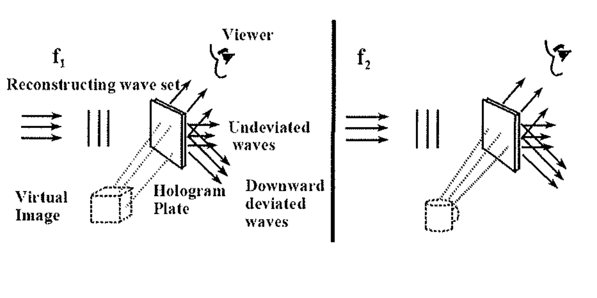

Figure 3: Holographic reconstruction. The reconstructive wave, modulated to frequency 1, reconstructs the stored wave front (image) of a cube. The reconstructive wave, modulated to frequency 2, now reconstructs the wave front of the cup.

reconstructed (see Figure 3, left/right). But if the reconstructive wave consists of a composite set of frequencies, f_1 thru f_n, a composite wave front or image is reconstructed. Note, in this last case, all is a matter of the "selection" of information effected by a given modulated wave passing through the hologram. There is no absolute or veridical virtual image specified by a particular reconstructive wave unless a god's-eye view is taken of the original object/reference wave set which is to be reconstructed.

While Bohm (1980) first introduced the notion of the holographic matter-field to physics, I think it safe to say that physics has routinely come to view this field as indeed a vast, dynamic interference pattern (cf. Bekenstein, 2003), where again the information for the whole is found at every point. If we take this as a postulate, the conjecture, then, is this: let us suppose the neural-dynamics with its re-entrant, resonant feedback, or if you will, the global wave of synchronous oscillations, is all conceived, very concretely, as supporting a wave, and more precisely, a modulated reconstructive wave "passing through" this external holographic field. The brain is not a "hologram." Put simply, the brain is the reconstructive wave. Now the dynamical, brain-supported pattern-wave "specifies" a virtual image of the matter-field. The modulation pattern is driven by the invariance structure or invariance laws defining the external event, while the energy dynamics of the brain supporting this wave, with its underlying chemical velocities, in essence defines a ratio of proportion relative to the field's events at the micro-scale of time. Dependent on its energy-state (i.e., chemical velocities), this dynamics and the wave it supports naturally defines the time-scale of the specified image of the field — a buzzing fly, or a heron-like fly, or a motionless, molecularly vibrating fly; a rotating cube or, as optimally as the available (invariance) information provided and constraints invoked, a wobbly, plastic-like object.[6]

This becomes a concrete realization of Gibson's abstract "direct specification" of events or of dynamic forms. It is a direct realism, but not simply a naïve realism. The image is always an optimal function of the invariance information available in the field in conjunction with invariance laws (constraints) built into the brain's design. It is a specification of the past motion of the field given the best available information within the field and given the intrinsic uncertainty of "measuring" this field due to its temporal motion. Being a specification of the past, it is always, already a memory, a memory

[6]Conceiving of the brain as a wave is certainly possible. Yasue, Jibu, and Pribram (1991) see the evolving brain states in terms of complex valued wave flows, where constraints on the brain's (state) evolution are elegantly represented by Fourier coefficients of the wave spectrum of this formulation. Glassman (1999), for example, attempts to account for the limited capacity of working memory by viewing the brain, globally, as a set of waves whose frequencies are confined to a single octave. However, I am asking here for a truly concrete construal and description of the brain as supporting a wave.

based in the primary memory supported by the non-differentiable evolution of the matter-field itself over time.[7]

There is a large array of "How-would-this-work?" questions such a model opens up, from the operation of memory to the nature of thought, language and cognition. I have approached some of these elsewhere (Robbins, 2000, 2002, 2006). The indirect realist immediately demands an explanation of illusions. Illusions, while certainly part of the qualia problem, would require a lengthy discussion. A brief comment will show the possibilities of specification as an approach. The phenomena associated with saccades, for example, appear to support indirect realism. When looking at a room, the eye darts from point to point over the area, in zigzag fashion, taking in information. During the movement itself, between the points, the eye is apparently blind, picking up no information. Objects presented during a saccade are invisible. While the visual system appears to be shut down for an instant in the saccade, the brain computes what we would have seen. Smythies (2002) argues that it would be implausible to suggest, per direct realism, that we see directly only when our eyes are not in saccadic movement. But the fact is that perception is as direct as ever. During the motion of a clock hand relative to a receptive eye (as in Yarrow, Haggard, Heal, Brown, and Rothwell, 2001), the always dynamic velocity flow information from the field is taken in, the optimal percept computed, and the reconstructive wave/specification is, as ever, to the past motion of the field. During the saccade, the brain-supported reconstructive wave does not cease. Just as for the rotating cube, this "wave" continues to specify a transforming field based on the information available and the probabilistic algorithm employed by the architecture.

Similarly, O'Regan (1992) noted that an entire page of surrounding text can be changed without notice during a saccade while someone is reading as long as the 17–18 character window the eye is focused upon is undisturbed. In a subsequent treatment of "change blindness" (O'Regan and Noë, 2001), the environment was conceived as an "external memory store" to explain the persistence of the perceived world during saccades. But the external memory store, i.e., the matter-field, of itself has no particular scale of time save the null scale. At the null scale of time, which is its non-perceiver relative or natural state, it looks nothing like the buzzing flies or rotating cubes of our normal scale of perception (cf. Robbins, 2004b). Again, we can better say that the reconstructive wave supported by the brain is not affected by a substitu-

[7]There is no homunculus here, no "viewer" of the image as in Figure 3. Implicit in the holographic properties of the field, where the information at each "point" reflects every other point, is an extremely elementary awareness at the null scale of time. The specification of a past motion of the field is then simultaneously a specification of a past, but time-scaled form and subset of this elementary awareness (cf. Robbins, 2000, 2002).

tion of the surrounding text during a saccade with its minute information gathering capacity; the brain-supported wave yet specifies a (time-scaled) form of the past motion of the matter-field.

The Quality of Color

From this view of specification, let me explore a little more deeply into that traditionally defining exemplar of qualia — color. I do not claim to list all the variants of position, but hopefully some main views. A current view of color is that of representationalism. According to this, the phenomenal character of experience is a "representational content." The representation is a function of some tracking or relationship between states of the brain and properties of the environment. Unfortunately, say, for the computer model, the representation for colors could only be different patterns of bits (0001111001, etc.). For the neural network, color is simply different connection strengths between firing neurons. This is the "coding" problem, pure and simple. Such a code can be unfolded only by some homunculus who already knows what the colored world looks like. There is a worse difficulty however. The highly prevalent view of color (cf. Bryne and Hilbert, 2003, for a review) is that there is no type of objective, physical property suitable for identification with our experience of color. Nothing is actually colored. The (white) coffee cup possesses no color. The (brown) coffee possesses no intrinsic color. Colors only exist as *subjective* qualities. For representationalism, color experience is in reality a vast illusion for us all. Objects are *represented* as colored in the "dark, quiet brain." Projective representationalism (cf. Wright, 2003) specifically takes the position that there are no color properties in the physical world that the representations are reflecting. Reflectances of light are a function of microphysical properties of surfaces, the end result being a fairly uniform illusion across observers. The origin and essence of this "no quality" position, I think the point has been already made, lies in the classical abstraction with its abstract objects in abstract motions.

Note that these color views of representationalism can equally hold for form. Form too must be a vast illusion. Objects, we should hold, are represented as having a form, yet there are no simple properties of objects that this representation of form is reflecting. The edges and vertices of the "rigid" cube disappear under the arrhythmic strobe. Form too would have to be a secondary property of the matter-field, and equally an illusion, and equally a problem of qualia.

Competing with representationalism are what can be termed qualia theories (cf. Wright, 2003). In this framework, the phenomenal character of experience is not fully captured by its representational content. Block (1990, 1996, 1998) motivated this conception with thought experiments wherein he showed that representations can be teased apart from phenomenal experience.

Thus qualities are supposed to be intrinsic, "subjective modifications" of our experience. The redness of an apple is not a represented property of the object/apple; rather, it is a property of my experience. Again, color experience is subject to massive error, but the error is not in the phenomenal character of experience, since in this view, the color qualities we are aware of are not the kind of thing we could be right or wrong about. The content of experience represents objects as having qualities they cannot have — the qualities are only "modifications of our experience."

For some, these positions may well appear to involve distinctions without a difference. When the representationalist states that color qualities exist only in the representational contents of our experience and our experiences misrepresent objects as being colored, we may say this is fine, but you yet have one problem: Where does the "red" of the representation (say of an apple) come from? If there is no color in the physical world, how does the brain (itself presumably physical) generate a representational content that is colored? To this there is resounding silence. When the qualia theorist states that the redness of an apple is a "subjective modification of my experience," whatever this phrase might truly mean, the same question resides: How does "redness" arise from a subjective modification? Whatever is this abstract "experience" such that it can be modified to become a red, white or blue experience? Whatever the supposed coherence and meaning of these positions, they are both alike in resting upon a mystical process for the birth of color. All possibility is removed, in these positions, for a scientific explanation of color.

Color and Specification

Zeki (1993) hypothesized that the brain is isolating invariants of spectral reflectance. The spectral reflectance profile of an object is given by specifying the percentage of incident light reflected by that object at each wavelength or over particular bandwidths. But there are multiple apparent problems, all supporting the view that there are no properties, such as reflectances, that specify color. Metamers, for example, are stimuli having different spectral reflectance distributions that produce the same experienced color. There is also the complex web of similarity relations among colors. Purple is more similar to blue than green, reds more similar to other shades of red. In this complex, there is an opponent structure: red is opposed to green in the sense that no reddish shade is greenish. So also for yellow and blue. There are unique hues (red, yellow, green, blue), and binary hues (purple, orange, olive, turquoise) — said to be perceptual mixtures of the unique hues. All of this appears as a problem for a qualitative field supporting color, for as Thompson, Palacios, and Varela (1992) note, light waves or surface spectral reflectances do not stand in relations to each other that are unique or binary, opponent or non-opponent, etc. There is no mapping from such physical properties to the subjective color experience. How can a theory of specification be reconciled to this?

As we have seen from our discussion of form, the brain has a more complex approach to the properties of this world. Byrne and Hilbert (2003) have argued that visual experience represents objects as having *proportions of hue-magnitudes*. Using their example, we can term the "size" of a rectangle to be the sum of two properties, height (H) and width (W). We can say that rectangle A has an H that is 25% of its size, or B (a "thicker" version) has an H that is 20% of its size, i.e., we are expressing A or B as having proportions of magnitudes H and W. Similarly, focusing only on hue, we need four hue-magnitudes, R (red), Y (yellow), G (green), and B (blue), the sum of which will be the object's total hue. A purple object is, say, .55(R) and .45(B), a blue object is perhaps .99(B) with very small proportions of R, Y and G. Thus, when we look at a tomato, the representational content (as per Byrne and Hilbert) is not simply a (determinate) red, but rather that the tomato has a value of R of 80% of the total hue and a value of Y of 20%. Given that we take L-intensity, M-intensity and S-intensity as the degree to which light stimulates the L, M and S cones respectively, then an object is unique red, according to the hue-magnitude proposal, if it reflects light with a greater L-intensity than M-intensity, the greater the difference, the greater the value of R.

Byrne and Hilbert speak in the language of "representational content," but we must remember that they have no theory of the origin of the external image, colored or not, i.e., they do not truly know what "representational content" is. Once the ambient light from the external environment is transduced to the neural–chemical code, or a digital code, or a connectionist weight code, etc., representationalism has no resources to solve the coding problem, i.e., it cannot explain how the coded "representation" is unpacked as the external image. We may, however, equally construe this "representation" as specification. The dynamical apparatus supporting this specification, with its L cones, M cones, etc., is selecting out information from the matter-field relative to action, just as a reconstructive wave selects information from the holographic plate. The specification of the tomato, then, as having proportions of hue-magnitude is, just as form, an optimal specification of legitimate properties of the tomato as part of the matter-field.

As noted, the problem of the origin of the external image is intrinsic to the problem of qualia, to include color qualia. Jakab (2003) is an exemplar of the tie. He accepts that objects are (physically) colored, yet, because of the many problems noted above around metamers, unique and binary colors, etc., he falls back on the concept of subjective color representations that yet require a "subtle form" of projection to achieve the feeling of external location (just as objects are seen as located external to the body). To explain this projection, he relies on "standard" perceptual processes employing depth cues, etc.: "Object colors are located external in space. Phenomenal color experiences are located in the brain" (Jakab, 2003). Remembering form, we would equally have to say that "objects are located in space, the phenomenal experience of objects is in the brain." Forgotten by Jakab is the fact that standard theories of perception equally have the coding problem; they have no theory of the origin of the external image — of objects or of colored objects or of colors themselves — whether within or without the brain, from the neural-encoded information. It is this lack of a theory of the origin of the image, located externally, in space, that drives the indirect realism Jakab is espousing. The nature and origin of color qualia, no less than that of form "qualia," in the final analysis is simply the problem of the origin of the external image. This problem, as I have shown here and elsewhere, is equally bound to our model of time.

Conclusion

If I were to state the deeper essence of this discussion, it would be this: the problem of qualia is an offspring of abstract space and its correlate, abstract time. In a small, but relevant digression, it is curious to wonder, had philosophy taken Bergson's critique to heart, if the qualia problem would have been posed, and would it have been evaluated instantly in the context of this critique? Would we have even considered the possibility that syntactic, symbolic AI programs, riding atop the operations of digital computers, could achieve qualitative perception? Syntax, in essence, can be defined as rules for the juxtaposition and concatenation of objects (e.g., Ingerman, 1966). This is again the reliance on abstract space. Further, the syntactic operations are scale-less. The rewrite rule S → NP+VP operates irrespective of scale, and the totality of such abstract operations give not a fig, either for the scale of time, or for the non-differentiability of the motion of the field from which they have been abstracted. The total explanatory burden of this approach was carried by the abstraction, which is why it could explain nothing. Here the critical import of the Chinese Room argument is driven to this metaphysical confusion — syntax, being again the abstract space, cannot be confused with semantics. Semantics rests in the realm of mind, mind embedded in the concrete, indivisible, time-evolution of the matter-field. There is, in other words, a natural addition to Bergson's "dichotomies": duration (concrete, indivisible time-flow) vs. abstract time, abstract space vs. the concrete extensity of the matter-field, quality vs. quantity. With these, syntax vs. semantics becomes a natural correlate. Abstract, symbolic operations, being the essence of an abstract space, cannot support the meaning of mellow, or specify buzzing flies, or the singing notes of a violin.

This brings me to the ultimate dichotomy, that of subject and object. It is on the subjective side of this divide that the concept of qualia has made its redoubt. But this too is a function of the abstract space. If there are not separate objects in the matter-field, the distinction between subject and object cannot be in terms of space. Rather, as Bergson argued (1896/1912, p. 77), the distinction is only in terms of *time*. If, starting from the null scale, we imagine gradually changing the energy state underlying the brain's dynamics such that it is specifying successively greater scales of time upon the matter-field, then the external fly moves from nothing more than waves in the field, undifferentiated from an equally wave-like observer, to an ensemble of vibrating molecules, to a motionless form, to a heron-like fly barely moving his wings, to the buzzing being of normal scale. Object is differentiating from subject.

The problem of qualia, I have argued, begins by ignoring what I have termed primary memory, also identified as the indivisible or non-differentiable time-evolution of the matter-field, that underlies all events, be it twisting leaves, rotating cubes or heron-like flies slowly flapping their wings. It continues on by ignoring the time-scale that the brain is imposing upon this field, an operation itself determining quality. Finally, being mesmerized in the projection frame of an abstract space, it accepts that the field itself may not be qualitative. All these assumptions and omissions must be seriously questioned, and the problem of qualia seriously reconsidered.

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