Neurophenomenology and Category Theory

The term 'neurophenomenology ' was coined by Varela, who also made a serious effort to understand consciousness (1,1a). It has to be said that it is a good idea to take his work at least almost as seriously as that of McTaggart (5), and indeed Lawvere. And there in brief is where I set up my stall for today's blog at least.

In his day (till 2001) Varela was probably at the forefront of neurophenomenology. However even as recently as the end of the last century, there was relatively little work on complexity theory and category theory as applied to neurophenomenology. The paper of Ehresmann (2) gives an account of how Ehresmann at least, tried to use category theory. And reference (2) at least explains how it could be done. Some ongoing work is being done, for example, by Brown (3). This indicates potential use of category theory which is anything but irrelevant and abstract.

Varela and the Specious Present

I should point out that though Varela wrote frequently about the specious present he does not seem to have ever actually used category theory as a working mathematical tool, nor to have given reasons why not. However both Varela and many others have clearly found coping with the specious present to be difficult, and certainly have not given convincing accounts on McTaggart's paradox. However when we read the account of Brown (3), for example, we can readily work out that at least a meaningful account of the specious present can be made. At this point we are not unduly concerned with emergence, for which Brown thinks he may be able to obtain answers and, apparently, even mathematical results.Further, I am not at all sure yet that a 'semantic web' (or Web 2.0, or whatever you wish to call it) is necessary or desirable either (6). However that is by the way.

What we can certainly try to do now is to use colimits in a way like Brown et al (4) tried to use them. There is a problem with Varela's work and it comes out clearly, for example, in section 3(2) ('The neurodynamics of temporal appearance') of reference (1a). I believe that one problem is that earlier workers have had to try to describe the McTaggart A series in terms of Newtonian time. Newtonian time is essentially punctal and in using it, we would have, very often, in effect to try to turn a blob into either one dot or into a series of dots. That is what happens to Varela. I will not give a bibliography here of all the other efforts to turn a blob into a dot, but they are common. For example, some of them are referred to in the references to (7). Symbolic logic certainly produces some intricate formulae but those do not describe an 'instant in time' very well either (7).

Colimits and the Specious Present

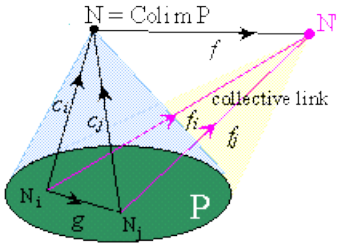
Brown has the enthusiasm to realise that category theory is good stuff. Now, for us to do what we want, we may not need to go quite so far as he does. We only need for the moment to consider an approach somewhat like that of Ehresmann. I append two diagrams from Ehresmann's study (8).

I will carry out this explanation in a way paralleling reference (8), so that anyone who reads and understands reference (8) may be able to refer back to it directly to help to make it clear what I am saying here. There are many important differences to reference (8) however.

Now for anyone who has not a copy of (5) on hand, Professor Soshichi Uchii's rough one-page summary (9), which does not go into all the subtleties of McTaggart's two volume book but will do for an introduction, is available on the internet. Uchii's summary at least tries to represent the A series as instants in time. (Don't worry about most of his comments or views at this stage).The B series can be a 'block universe' or some other punctal time representation that we care to use.

We don't worry about the McTaggart paradox as such at this point either, we just set up a McTaggart style representation.

We consider an instant P as a pattern of past present and future. This could be at this point the past present and future of the universe or of one object, say an observer, in a universe.



In a category, a pattern P is modeled by the data of a family of objects Ni and of some distinguished links between them. A collective link from the pattern to another object N' is a family of individual links fi from each Ni to N', correlated by the distinguished links of the pattern, in the sense that, if g is a link in P from Ni to Nj, we have gfj = fi .

The collective links model collective actions (constraints, energy, or information transfer) of all the Ni acting in cooperation along their distinguished links, and which could not be realized by the objects of the pattern acting individually. The cooperation can be temporary, as in a group of people who decide to cooperate for a particular work. But the association itself can be represented in the system by a more complex object N, which 'binds' the objects of the pattern and acts by itself as the whole pattern, in the sense that its links to any object N' are in 1-1 correspondence with the collective links from the pattern to N'.

In a category, the object binding the pattern (if it exists) is modeled by the colimit (or inductive limit) of the pattern. An object N is the colimit, or the binding, of the pattern P if it satisfied the two conditions:

1. there exists a collective link (ci) from the pattern to N,

2. each collective link (fi) from the pattern to any object N' binds into a unique link f from N to N', so that fi = cif for each i.

If a pattern has a colimit, it is unique (up to an isomorphism). In this case, we also say that the pattern is a coherent assembly and that its colimit represents a higher order object which subsumes the activity of the assembly.

The colimit actualizes the potentiality of the objects to act together in a coherent manner by integrating the pattern in a higher unit (for example, the protein as such). In a natural system where the links have a given 'strength', the formation of a colimit is characterized in two ways:

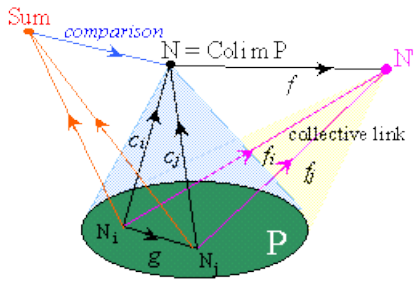
1. 'locally and structurally', a strengthening of the distinguished links of the pattern restricts the degrees of freedom of the objects to ensure a more efficient cooperation among them;

2. 'universally and functionally', the actions of the colimit on the other objects of the system subsume the activity of the whole pattern (they correspond to its collective links).

For example, a molecule is the colimit of the pattern formed by its atoms with the chemical links defining its spatial configuration.

Roughly, the colimit forgets the precise organization of the pattern and records only its collective actions, and these can be the same for more or less differing patterns.

The rôle of the distinguished links of the pattern P is paramount: they determine the 'form' of the colimit and allow for the emergence of collective actions, transcending the individual actions of the objects. The coherence and the constraints introduced by these links can be measured by comparing the colimit to the simple amalgam of the objects Ni of the pattern, obtained if the links are forgotten, which is modeled by their sum.



The sum (or coproduct) S of the family (Ni) is the colimit of the pattern P' formed by these same objects but without any distinguished link. It classifies the individual actions of the objects, while the colimit of the pattern P classifies their collective actions made possible thanks to their distinguished links in P. (Think of the difference between the behavior of an unorganized mob, and the behavior its members adopt under the direction of leaders.)

There is a comparison link c from the sum S of the Ni to the colimit N of P, which binds the canonical links from the Ni :to N. It measures the constraints imposed to the objects by their distinguished links, hence by their participation to a collective action. The links from S to an object N' which factor through c correspond to the emergent properties of the complex object N compared to the properties of its components Ni.

Now we could say that a series of 'instants' P, which we could call {P} could occur as part of an ordered set or otherwise but we do not have to do this. And each 'instant' has its own past-present-future. And a series of instants will exist in some category Cp, say.

The specific 'instants' are not like a series of beads to be hung on a string, but form significant but differing parts of a whole. In a sense each instant could be taken as a past-present-future representation of some whole. The whole could form a specific structure, possibly a category we might like to call MacA.

It is important to note that there is no simple mapping between such a structure as MacA (which has a clearly defined mathematical meaning and could perhaps be regarded as our "A series") and linear time, as normally described in relativity theory or in ordinary Newtonian physics, which could be described as a "B series" or MacB, a different category. Here we can try to incorporate all the important properties of a McTaggart A-series in our model and all the important properties of the McTaggart B-series in a relativistic or Newtonian model and we find that while some sort of mapping between the two is of course perhaps possible (just as pretty much any two finite things can be mapped to one another) it would be an odd and confusing many to many mapping and its possible creation should not offend the McTaggart 'paradox' nor imply that time is unreal per se.

Interestingly enough, our A series model also corresponds to the sort of thing we would expect of living systems. This does not of course presuppose that it is suitable for cell structure for example. But it looks like there could be at least two suitable models, one good for cell structures and one for specifically mental (consciousness) models and whilst these could overlap or even be identical or hierarchical, they do not have to be and we can still flesh out the mathematical bones of MacA as adequately as we wish or desire. In no way do we require, or imply, a TOE !

I hope I have made the above clear so far.

At the bare bones level, as an illustration of the above, we could consider a house and a car to be mappable onto one another but that in no way renders the two as equivalent concepts. Assumed equivalence between a house and a car, per se, would not normally need to be anything other than a philosophical and logical muddle in commonsense cases of paradoxes in the real world. We would not, for example, normally live in a car or drive a house (though both have been seen). In the same way we would not normally try to map the A series (with a more or less precise mathematical description now, somewhat like a car has a more or less precise description in terms of say size, colour,speed and the like) onto a house, which also has such a description with significantly different details. Sometimes of course we might map a house onto a car, for example if we thought of purchasing one or the other. In that case we would presumably map the prices and mortgage payments of each vis-a-vis the other, and possibly vis-a-vis our net salary as well. But in other than very carefully chosen and designed special cases like that, we could not normally expect anything other than confusion if we try to map at a useful level of detail, the A-series onto the B-series as both manifestly have more complex and varied and fundamentally different features than a house and a car.

Anyone still not convinced by the argument could consider the inverse situation where we consider the A and B series to be essentially (roughly) the same, to the extent where one can be mapped roughly isomorphically to the other in the way that McTaggart seems to want to contrive.. But this would mean on a routine basis we could take a house and a car to be the same. Perhaps the fact that we perceive differences between the A and B series has something in common with the fact that we perceive differences between objects in general. The common denominator could in this case be downward from time to object perception, and not up from object perception to time. Perhaps McTaggart's greatest achievement was to show the two differing facets of time when there was (in his day, or indeed properly at all until category theory was developed) no simple mathematical description of the differences between and innate complexities of the two aspects of time which he had claimed existed. McTaggart himself of course, did not fully appreciate what he had done and had taken instead the idea that it proved the unreality of time, a very natural conclusion perhaps, in those days of lower mathematical sophistication. The development of these mathematical features, using category theory, is now given here in this blog. For example: At a stroke, we may have removed many of the very real problems with relativity theory that many people, Prior in particular, had noted. This is because we normally admit in such cases, separate and distinct categories for A and B series.

The important point now is that by using category theory, we have put some mathematical flesh on the bones of McTaggart's A-series. It is also implied that the A-series could be of particular significance in determining the details of the mind and consciousness. This would even be the case if we happen to espouse physicalism, but it would still be of significance even if we don't. There certainly is no reason why other categorical interpretations can be set up but here we have kept to past-present-future and earlier-later cases. To avoid the paradox, these have to be separate.

We now could compare with Isham's or Gout's different work, or for that matter Ronald Brown's work but we certainly do not require exact correspondences with any of these.

Well, that is as far as we will take it in this blog entry. Any correspondence or comments are welcome but we shall proceed in any case. This is a difficult subject and constructive comments are welcome.

In further blogging we want to stick, where possible, to the conventions of (10) and in due course may be making use of the computer program (11) for some of the mathematics. This of course does not forshadow any extreme philosophical representations, such as the 20th Century notion that the human brain can be (or can't be) replicated in a computer.

References

1. Varela F.J. , Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science Edited by Jean, Petitot, Francisco J. Varela, Bernard Pachoud and Jean-Michel Roy Stanford University Press, Stanford Chapter 9, pp.266-329

1a. The Specious Present : A Neurophenomenology of Time Consciousness Francisco J. Varela. in: J.Petitot, F.J.Varela, J.-M. Roy, B.Pachoud and (Eds.), Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science, Stanford University Press, Stanford

2. Ehresmann C., http://perso.wanadoo.fr/vbm-ehr/Ang/W24A5.htm

3. For example Brown R., Paton R., Porter T., "Categorical language and hierarchical models for cell systems", to appear in Computing in Cells and Tissues - Perspectives and Tools of Thought', Springer Series on Natural Computing.

4. More preprints of material like (3) such as 05.13 at http://www.informatics.bangor.ac.uk/public/mathematics/research/preprints/

5. McTaggart, J M E 1927: The Nature of Existence, Vol. II. Cambridge: Cambridge University Press.

6. One unforunate result can be seen in the shortcomings of such as Wikipedia, often trumpeted as a precursor of 'Web 2.0'. I remain to be convinced that present difficulties with the semantic web will be dealt with other than by methods which will destroy the ultimate intent of Web 2.0

http://www.theregister.co.uk/2005/10/18/wikipedia_quality_problem/

During the writing of this note, it is said the situation is to be improved but currently the outlook is nonetheless definitely still not good and my comments in The "Fabric of Reality' egroup still very much apply. ["Wikipedia tightens editorial rules after complaint", New Scientist news service, 06 December 2005] .

7. For example "Being and Becoming in Modern Physics" from the Stanford Encyclopedia is full of spacetime diagrams and symbolic logic which just does not cut it. http://plato.stanford.edu/entries/spacetime-bebecome/

8. http://perso.wanadoo.fr/vbm-ehr/Ang/W208.htm

9. http://www.bun.kyoto-u.ac.jp/~suchii/mctaggart.html

10. "Conceptual Mathematics", Lawvere C.W., and Schanuel S.H. , Cambridge (2005). AT imes the

conventions of "Basic Mathematics for Computer Scientists", Pierce B.C..(1991) may also be needed. I am trying to keep it all as simple as I can.

11. "Graphical Database for Category Theory", Version 2.0, Jeremy Bradbury, Ian Rutherford, Matthew Graves and Robert Rosebrugh July 1, 2002