REDUCTIONIST MODELS OF MIND AND MATTER: BUT HOW VALID IS REDUCTIONISM ANYHOW?

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ABSTRACT

Reductionism — (our viewing of real systems in terms of their supposed parts in order to explain or predict), is surely something we all do, at least informally. However it is often disparaged as inappropriately applying crude mechanistic concepts to affairs which involve human sensibilities, or of being ineffective in such attempts.

Here one envisages a model built up from basic-element parts (comparatively stable, ideally eternal: metaphorically "bricks"). It obviously helps if these "brick"-ideas are sharply defined, though even vague entities can be useful in guiding hypothesis-building. So, when are such models helpful, and are they ever misleading? There are two different sorts of verdict, though the issues are often mismatched or mixed, leading to mystery and confusion:

It seems well-known that *Prediction* needs: •fairly precise working models (be they algorithms, machines, or formulae), •a ban on trying to *predict* (rather than explain) a remote effect from a trivial cause, and •a way of coping with unexpected "emergent" effects.

In contrast, if our aim is *Understanding*, we face different issues: Here we seek to link acknowledged phenomena back toward their root-causes — over as many causal steps as we wish, as long as we take them one-or-two at a time. However we do need to already have reductionist sub-models for all the relevant steps, — *and* a psychological "mental set" for accepting each of those steps as "natural". Competent teachers know how to achieve that in practice, but it is debatable whether we fully *understand* this understanding!

This process fails (and slips tacitly into mythology) whenever any key sub-model is false or missing. One notable critic blames reductionism itself for our inability to explain (e.g.) many essentials of brain-theory. However it is argued here that the real problem in his example lies in faulty assumptions-about-synapses in mainstream neuroscience; and that an alternative sub-model (largely neglected since the 1970s) can resolve the critic's objection, *without* blaming reductionism.

1. Reductionism & Models of Reality

For a variety of reasons we feel the need to construct models of the world about us — be they mental models within our minds, or structures and descriptions within our social community. Indeed these models may be potentially-dynamic, with supposed representations of *working parts* attributed to reality.

That all raises the question of whether such "reductionism" is always acceptable and/or helpful.

1.1 What is Reductionism?

Broadly speaking, reductionism is the notion that any dynamic system has some sort of discernible relationship with its parts; — and (if we can find out enough about this relationship) we will then have a good chance of predicting some aspects of its future performance and/or explaining its past behaviour, etc.

That seems obviously valid for reliable machines, but what about complex systems where there are relevant happenings for parts-within-parts-within-parts-…? E.g. (i) Human Social systems? (ii) A beehive? (iii) An amoeba?

1.2 My own Dilemma over Reductionism

On the one hand, as a post-grad student I had long-ago been trying to work out what biologically-credible mechanisms could possibly explain human intelligence — applying my diverse background in psychology, biology, physics and IT, and arriving at an account in which *each step could be described as mechanistic and reductionist*, even if the total model evaded such verdicts. Meanwhile, to help me in this mechanism-seeking task, I had also taken-on an excellent single-subject correspondence-course[1] based elsewhere, and headed by Professor Steven Rose.

On the other hand, it *later* came to my attention that Professor Rose was freely condemning reductionism — apparently in all its forms. Given that I had taken reductionist inspiration from his course, I found his pronouncements surprising and perplexing, especially as none of his works at that time seemed to *explain* these objections, nor even define the problem clearly.

Certainly there will be circumstances in which reductionism seems inappropriate or maybe just overexuberant in its claims, but surely that does not always apply. Anyhow my present purpose is to clarify these issues.

1.3 Reductionism in Everyday Use?

It helps if we look at various aspects of reductionism when we may seek to use it to model reality. And note that such models can either be in the *public domain* (mechanical, computer, or mathematical), and/or in the *private domain* inside our heads!:

What is Our Aim? To Understand, Predict, or Blame?

We should be clear about such objectives, because the requirements can be significantly different, and some writers seem to have confused these conflicting aims.

(For the moment let us keep to cases where "parts" are confined to those *immediate parts*, one level below as in Fig.1, rather than "parts of parts of parts" etc.).

I am personally mainly interested in *the Understanding aim*, partly because it seems to have been neglected hitherto. Hence I will concentrate on it for most of this paper, but let us first look at the other two:

Blame

I won't say much about **blame**, except that it is a basic issue for lawyers, often dealing with a rather specialized-and-curtailed models; and that the level of required proof should be higher than usual, especially as there may be no good way of reversing a faulty decision.

Prediction and Planning

For good **prediction**, we need some *well-defined "bricks-for modelling"* at the lower level *and/or well-defined procedures* for interpreting any relevant formulae etc.
(e.g. a tangible material way of modelling "sin(x)").[2]

To the extent that such absolute precision is missing, the prediction will be increasingly unreliable — though it might still be useful especially if we recognize its limitations.

The biggest problem arises from emergent non-linear effects, like *missing a deadline*, or *a cam-shaft breakage* or *unexpected drug-interactions* — though we might be able to cope with these phenomena if we have a large population of such systems so that we can deal with them collectively using statistics. Otherwise we usually have the major problem of *a large number of possible future event-paths, and we may have no idea which one will apply (even if we were to foresee all those possibilities)* — and that rather spoils our hopes for any useful prediction.

Obviously good predictions are much sought after: ("Oh for a Delphic Oracle to tell me my future!"), but they may be rare

[1] "Biological Bases of Behaviour", with the UK Open University. E.g. See the associated book: Chalmers et al. (1971).

[2] Such precision will usually be found primarily in the public domain (incl. Science-as-Such) rather than the mental domain of individuals.

and/or expensive. In particular we need them for *planning* — even if we do not actually *understand* them (which takes us to the next subsection):

Do we Understand Understanding?

To understand **understanding**[3] we need to venture into Psychology, and that entails some *model* of what the Mind/Brain is doing. For such a model one needs to add some hint of mechanism to offer the "bricklike" base for substructure (as discussed at the start of the "Prediction" section, above). Piaget (1967) selects as that "brick" a merely-abstract entity, the "schème". That has been well used in Piagetian theory, and it *might* do for our purpose, [though later work suggests that such schèmes *are* material, and probably consist of ncRNA.[4]]

Given this double requirement of "Mental-model" + "brick-like elements", I suspect most writers on reductionism just tacitly avoid this arcane "understanding" issue. Indeed these ideas are still hypothetical; but despite that, they are still useful in trying to spell-out the nature of reductionism.
(Such provisional use of hypotheses until something better turns up is in the spirit of the new non-axiomatic approach).[5]

In any case, Piaget's idea was that such schèmes (i) code for *action* ; (ii) can combine (virtually?) to represent 2D and 3D objects, initially by *actions tracing* their outlines ;
(iii) they can combine further (virtually?) to offer other structural models purporting to represent reality.

Going beyond Piaget[6]: (iv) Various compound-schemes could plausibly have different affect -"labels" such that they are switched on-or-off depending on endocrine cues, etc.

Going further, there is (v) the reasonable working hypothesis of the build-up of a neat self-coherent compound schème[7] and (vi) hence generate some feeling of *Satisfaction and/or Reality* — which would amount to *Subjective Understanding.*

You may doubt this account of what the brain may be doing internally, but note the way that the real-world phenomena are conceptually broken up into parts (with awkward things like solid objects reduced to tidy action-codes). If the brain actually handles such things in a different way entirely,[8] then so be it, and let's hope we discover it soon — but meanwhile we have a working concept of what it is to understand.

Moreover the more overt aspects of this picture seem to be consistent with what efficient classroom teaching requires.

Is Reductionism Needed for Understanding?

If our minds do actually operate in the above-mentioned way, (and maybe even if they don't) then we probably do need (to some appropriate extent) to conceptualize systems in terms of their parts. These supposed parts might be real or imagined, but if we are after a *true* explanation we should try to ensure that our conceptual parts correspond to plausible parts within the real world — at least approximately. We should then be in a position to test these concepts, either experimentally or checking on the self-consistency of ideas, or preferably both.

Anyhow it seems that reductionism is at least very useful if we want to understand (rather than just formulate) the world around us — and I shall offer as a provisional working-rule *that reductionism is essential for our subjective understanding of the world.*

Reductionism and Public policy

(This takes us back briefly to the "Prediction and Planning" issues of the previous section).

Understanding is not actually essential for managing affairs. Bureaucracies have the sometimes-justified reputation of acting either blindly, or by formulae which no-one really understands. Indeed that arrangement might even work quite well, as it often does in nature (evolving by a slow mindless Darwinian process), as long as "the outside world" does not change too quickly or drastically. But if the world does suddenly change, then understanding is the best hope for survival — and that seems to require adequate[9] reductionism.

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[3] Such apparently-circular reference in an unavoidable feature of knowledge-theory (epistemology), because one is using the epistemological tool to study epistemology itself. That accords with post-1980 philosophical thought replacing "feudal" axiomatic logic with an interactive network of concepts. (Traill, 2000, p.6).

[4] (Traill 2005b, www.ondwelle.com/OSM02.pdf), and (Traill 2012, www.ondwelle.com/MolecularScheme.ppt).]

[5] Cushan (1983, thesis www.ondwelle.com/ValueJudgements.pdf) and/or Hilary Putnam (2002) "*The Collapse of the Fact/Value Dichotomy*", Harvard U.P.

[6] as discussed recently on the ResearchGate website.

[7] E.g. see Traill (1976/2007) "Short papers and letters on … Mental Mechanism and … method" www.ondwelle.com/OSM06.pdf

[8] Yes, there is evidence that the brain does have at least one other *alternative* way of handling image-concepts; but it seems likely that these two approaches co-exist and cooperate: (Traill 2015: www.ondwelle.com/VisionTheories.pdf)

[9] Perfect reductionism is usually not possible, especially in the social sciences, but one can at least make an effort. E.g. I was amazed at the USA's gross failure to comprehend the psychology of individual Iraq citizens before, during and after the invasion in recent years.

Focus here on Understanding via Reductionism

Much has already been written about the problems of *prediction* in the face of reductionism — notably the complications arising from "emergence". So, to keep the current text within bounds, I will continue to concentrate instead on the issues of *understanding*, and its apparent need for *reductionism* — and that will usually be in a present-time or historical context, rather than predictive.

1.4 Multi-stage Modelling

Looking at Fig.1, we can recall that, so far, we have confined the discussion of *single-level* reductionism: E.g. almost "completely" understanding a particular chemical reaction (like $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + energy) in terms of its *("undissected") atoms* and their binding forces. That may be fine for our purposes if we see these atoms as sufficiently stable-and-permanent (as required for a good reductionist explanation which takes them as the basic "bricks").

But what if we are considering (e.g.) Plutonium compounds? Then any standard chemistry might be grossly disrupted by events on a lower scale — the disintegration of Plutonium atoms themselves. Or, in the social sciences, our supposedly standard, reasonably predictable population of citizens might suddenly be rent apart on some unforeseen political issue.

Multi-stage Understanding

Usually such multiple layers should not cause any great difficulty for **understanding** (if we are getting unbiased information, and enough time to digest it). In principle, it will just be a matter of explaining each level separately (mostly in terms of the one below ***if*** we have a valid model for that level) — and then, if necessary, linking these explanations together — provided complexity does not overtake our attention-span! And if we seek to explain *every level in Fig.1 (and beyond)*, then we simply take each level as separately as possible, and then (if we so desire) seek to combine-or-link them all.

If we do ***not*** have a valid model for whatever lower level we are interested in, then we may see fit to seek information about it by whatever means possible. One approach is by direct empirical investigation (e.g. using anthropologists and/or market-researchers in the social sciences, or geneticists to explain a new apparently-hereditary disease).

Another approach, described below, is to skip over any hidden unobservable "black-box" levels (whilst noting their likely "job description") and turn to whatever "bricks" there might be in the layer(s) below that. Given some knowledge of those ultra-micro "bricks", it may then be possible to

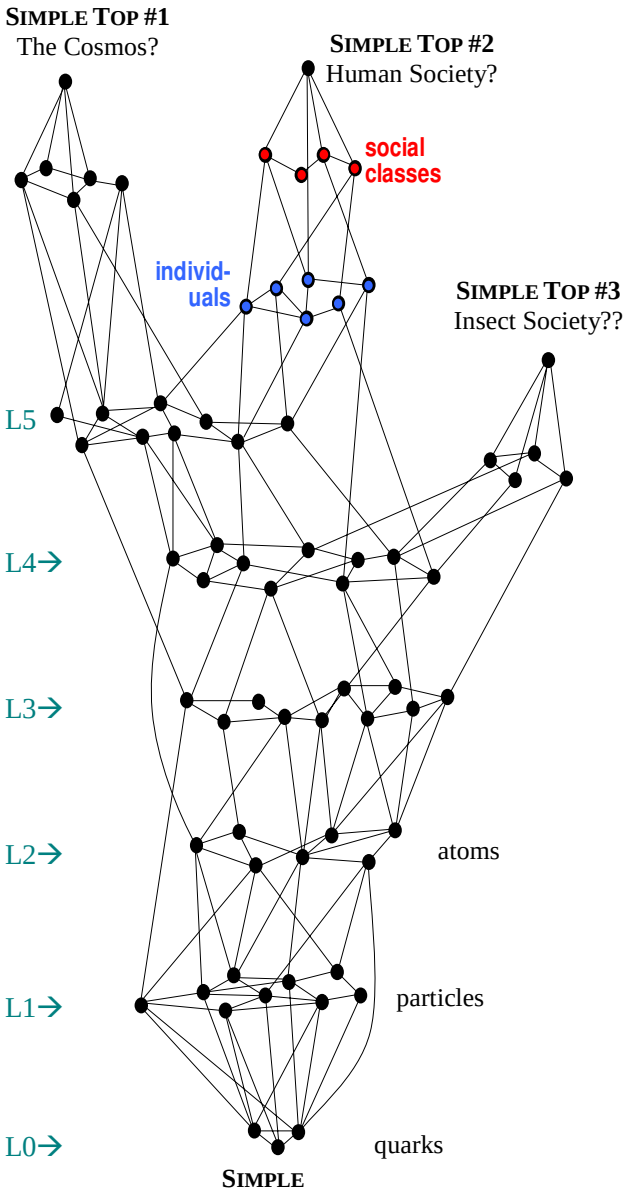

fig. 1

A schematic view of the structure and substructure of reality as we know it, but vastly simplified and probably inaccurate generally — though it will suffice here.

(The numbering for the scale L0, L1… is somewhat arbitrary)

[Adapted from the online book Traill (2000; fig. 7:2, page 40)]

reverse-engineer the black-box mechanisms, without actually observing them![10]

Multi-stage Prediction?

Prediction up through multi-layers is a different matter altogether. (We have seen above that post-hoc *explanation* can focus largely on *one* historical path — what actually happened). — But now, in contrast, *prediction* has the choice of a possibly infinite number of possibilities to choose from. That can be a formidable task, especially if the "bricks" underlying one's model are somewhat vague.

Depending on that "brick precision" one might be able to make worthwhile predictions (perhaps only statistical) some two levels up; but that would be somewhat chancy. As for multiple levels, that is quite out of the question. Indeed (if I remember correctly) it was this sort of bizarre example which Professor Rose ridiculed in one of his early critiques of reductionism — but that seems to be confusing *post-hoc explanation* (that the chance-loss of a horse-shoe nail had led to a specific major disaster), versus some *supposed prediction* that this would happen.

That perhaps goes half way toward answering Professor Rose's critique of reductionism. For further answers we will need to look into a particular study of the Mind/Brain — the study already alluded to in the discussion of Piaget's "schème" and its supposed structure-building capabilities, as follows:–

2. Rethinking Mind/Brain Theory

2.1 New Model for Brain's Advanced-Thinking

The textbook account of the nervous system still depicts what I call "**System** [**A**]": **A**ction-potential voltage "spikes" (about *1 m.sec* duration) as the basic signals; and evolving synaptic links between neurons as the repositories of memory. Such a view is partly supported by **(i)** the fact that the system is obviously doing something important and relevant (even though no-one seems to have decoded any non-obvious messages, and its adaptations seem too slow for what is expected of it); **(ii)** the fact that such items and their activities are readily *observable* (as Popperian doctrine demands[11]); and **(iii)** they seem to fit in with the neural network theories of D.O.Hebb (1949) even though Hebb himself (1949 and personal letter) insisted that his "formal neuron" need not be an actual neuron at all, but could well be a node at molecular level. Indeed as more became known about actual neurons, the less suited they seemed for the precision-or-digital tasks which Hebb had in mind.

Such thoughts prompted a search for "RNA-like" string-molecules and the possibility of identifying them with Piaget's abstract "schème" elements of encoded action (reminiscent of computer subroutines!). See (e.g.) Traill (1976/2007, Ch.III: www.ondwelle.com/OSM06.pdf); — and (Traill 2012 www.ondwelle.com/MolecularScheme.ppt)

One serious problem here was that those Action-potential spikes would be a totally inefficient means to communicate with such ultra-micro ("broadband") codings. Quantum considerations suggested "Near" infra-red (IR or NIR) *instead.* Hence the provisional postulate that, for advanced human thought at least, the relevant mental system would be RNA-like static coding, mostly interlinked by IR signals which I choose to call "**System** [**R**]".

As a further twist, this system would probably use the myelin nerve-fibre cladding as a fibre-optic coaxial channel (without impeding its other accepted role within "[A]")! (Traill, 1988/2009; www.ondwelle.com/OSM10en.pdf) and the book (Traill, 1999; www.ondwelle.com/BK0_MU6.pdf)

That optic-fibre postulate might seem outrageous (except to physicists and engineers), but recently it has actually been shown that such transmission *is* possible! (Sun *et al*, 2010). In fact such stray photons of IR ("Ultra-weak[12] Photon Emissions" — "UPE"s) have been known since 1923, but only now are they (occasionally) being taken seriously in English-speaking countries! (Traill 2011a).

[10] This backdoor approach is formally similar to prediction, and may share the same problem of too many choices (unless the "black-box" task is so difficult that there are very few possible choices).

[11] Popper's role (1934) in "scientific method" (a branch of epistemology) has been important but ultimately unfortunate, and that was generally realized amongst epistemologists (if not scientists) by about 1980! Arguably his two basic mistakes were **(i)** His main agenda of opposing induction **(**admittedly fallible, but now recognized as essential anyhow— Cushan (1983), and/or Hilary Putnam (2002) "The Collapse of the Fact/Value Dichotomy"**)**
(ii) Tacitly accepting the empiricist agenda of the Vienna Circle when he could have explicitly *also* allowed "testing" to include tests for internal consistency — which is arguably *just as* important as the observable empirical tests in the outside world.
Testing is surely vital, but don't we need *both* types?
One relevant case study is Traill (2005c) "How Popperian positivism killed a good-but-poorly-presented theory — Insect Communication by Infrared", *Gen.Sci.J.*, http://www.ondwelle.com/OSM03.pdf

[12] ultra-weak as measured in the lab, but not necessarily weak *in situ*!

A further complication — though much more speculative — is the possible existence of a **System** [**U**] involving UV photons (which have also long been known among the UPEs). Such photons would have about ten-times as much quantum energy compared to NIR, so they might be employed in making more drastic changes such as epigenetic "switching", (or doing more damage if misdirected). (Traill 2011b, 2010).

Such switching might have some relevance to the suggested encoding of long-term memory onto DNA (Arshavsky, 2006). In any case, we might agree with his misgivings regarding the [A] system as a poor basis for long-term memory (LTM). — Indeed we might go further and doubt its use for short-term intellect-and-memory as well, though clearly it does have vital roles such as linking to the outside world, and such skills as pattern-recognition. Moreover it *might* also serve to organize the logistics for [R] in the light of changing circumstances — building new synaptic "branch offices" as the occasion demands — but of course that is just speculation at this stage.

2.2 Failure of the [A]/Synapse Monopoly

I have long doubted the adequacy of [A] for intellectual thought. *Arshavsky* seriously doubts its capability for LTM, and *Hebb* himself had his own misgivings. Now it seems that even Professor Rose is very unhappy about it, though he does not yet seem ready to give up its tacit monopoly role.

Here I quote from my Rose-quotes within the new preface to (Traill 1976/2007: www.ondwelle.com/OSM06.pdf) where I discuss Rose (2004; p.215):

[a] "Hebbianism[13] is not sufficient ... it cannot account for the ways in which ... the putative memory traces are disassembled and redistributed."

[b] "Nor can it account for the renewed lability of memory following a reminder...";

[c] "We have no idea how recall occurs,..."; and

[d] "Nor do we understand how chicks, and humans, derive a coherent image from...distributed cues, the, so-called, binding problem."

To which I respectfully suggest that:
The answers may lie in a radical *Darwinian* explanation.
If we are dealing with molecular elements rather than cellular or even synaptic elements, then there is a vastly greater population of coding-possibilities, and one can afford to select from prefabricated candidates whilst rejecting the rest. Thus nothing needs to be "written", not even addresses. Such details are already "there" if they exist at all. (That does not forbid Lamarckian "writing" ***if*** the system can manage to design and maintain it, but it makes such design unnecessary).

Call-*or*-recall is likely to occur when some relevant IR stimulus appears. (Its original address-seeking code would be arbitrary, but it has an adequate chance of happening-upon some unplanned-but-corresponding address). All unplanned, but the randomly generated "key" will probably continue to work for the same found address! (Traill, 1978; espec Ch.C6).

The [d] answer might be gained by working on the schème-ensemble ideas in the above-mentioned (1976/2007 itself: Ch. I-II). See also Traill (2009; www.ondwelle.com/OSM12.pdf).

Rose seems resigned to some ineffable mystery

Faced with what he thinks is a dead end, Professor Rose seems to have turned to a sort of romantic vitalism, in which he explicitly rejects reductionism. Here I quote from Rose (2015). The underlinings and "[…]" remarks are mine, (RRT).

He starts, commenting on neuroscience 50 years ago:

> Had not the great Francis Crick moved on from DNA to neuroscience, claiming, as he did in *The Astonishing Hypothesis*, "You're nothing but a pack of neurons"? I shared this reductionism, even writing a book grandiosely called *The Conscious Brain* [1976/1973] a title I would now renounce, as in my older and hopefully wiser age, I recognise that it is people, not brains, who are conscious, albeit we need our brains to be so. But despite our optimism, "solving" the brain, or even "curing" mental and psychic distress, was then beyond our empirical or theoretical capacity.
>
> Fast forward the half-century, and where are we now? Techniques inconceivable then have transformed neuro-science labs. Genes can be modified or novel ones inserted into mice, designed so that they can be turned on or off...
>
> [List continues for about 14 lines, then…]
>
> But many of the problems that had beset the early days remain unresolved. Neuroscience may be a singular label, but it embraces a plurality of disciplines. Molecular and cognitive neuroscientists still scarcely speak a common language, ……
> For many of the … [Molecular neuroscientists], reductionism rules and the collapse of mind into brain is rarely challenged [though as "brain" here presumably means "[A] system", I would seek to *replace* it with a *revised* reductionism — the [R] system. — RRT]. …
> [Whereas] cognitivists … regard higher order mental functions as emergent properties of the brain as a system. [←obviously?? Surely any complex dynamic system will generate unforeseen emergent configurations — and often that is the very point of such systems if they happen to be man-made . Here Rose seems to be implying that such emergent properties are vitalistically magical and hence somehow transcending reductionistic modelling. If so, then I would dispute that interpretation — (but anyhow that takes us back into Prediction although post-hoc Understanding is now our main focus).]

In response then, my thinking is:– **(i)** Reductionism can work well *provided your underlying model is not defective* (which could be the problem here); **(ii)** emergent properties are just what we should expect from complex systems, so (in general) that should not be a surprise problem; and **(iii)** so surely these two ideas should simply coexist!

[13] I presume he means what I call "[A]". RRT 31/12/2015.

In any case, as far as I can see, that seems to explain the other half of Professor Rose's objection to reductionism; and meanwhile I see only benefit from judiciously using it myself.

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