Coherent Infra-Red as logically necessary to explain Piagetian psychology and neuro-microanatomy —
Two independent corroborations for Gurwitsch’s findings, and the importance of self-consistent theory

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Abstract. We can infer mechanisms underlying advanced human intelligence via •physics, chemistry and information-technology; but also •epistemology: analysing all knowledge-building processes (based on selection amongst micro-ideas). Hence Piaget offered “schèmes” as such items of thought/action, to account for actual human behaviour. In microphysiological terms, basic “schèmes” should have digital properties and a one-dimensional organization. That implied RNA-like molecules (and their “chorus” groups). — However for the necessary fast intermolecular communication, traditional action-potential “spikes” would be much too coarse. The alternative is Infra-Red. It then appears that myelinated nerve fibres seem suitable for an unexpected second role as coaxial cables for IR! — Such OPTICAL interpretations also explain several enigmas: •What keeps (myelin-thickness / axon-diameter) ≈ constant? — (a mystery since 1905). •Why PNS myelination is delayed until the axon diameter reaches 1μm. •Why myelin often stops growing at a predictable angle in its wrapping. •Callahan’s anomalous failure to detect sensory action-potentials even though his insects were responding to invisible IR signals. (Meanwhile RNA-LIKE CODING explains •inherited behavioural traits, and •memory—“recording” as Darwinian!) — The important point: Here IR is independently identified as a necessary solution to logistical problems. In contrast the Gurwitsch tradition first discovered emissions, and then sought explanations. Thus the two approaches corroborate.

Introduction

§1. Mainstream science has not yet really accepted Gurwitsch’s 1923 discovery of “ultra-weak radiation” from living tissue, [1,2] despite the increasing evidence for its universal nature. At best, such infra-red and ultraviolet photons are perhaps grudgingly accepted as “a quaint sideline which need not bother us” — forgetting the huge importance of those other quaint sidelines investigated by Galileo, Oersted, and many others.

Why this neglect of bio-emission? — And can we remedy such negligence?

† or, if obsolete, consult the website: www.ondwelle.com
Here I report a project which might aid acceptance in two different ways: Firstly, as we shall see in Part B below, it offers independent corroboration — applying Information-Technology to conclude theoretically that infra-red (IR) signalling is necessary to explain advanced intelligence within the brain; — a conclusion which initially arose in total ignorance of any ultraweak evidence, thus ensuring independence.

The second mode of assistance is less obvious, but more fundamental so I shall deal with it first. (It deals with the theory of knowledge-acquisition — both by any brains we study and by the scientific establishment itself as “Scientific Method”. The more physiological issues are deferred until Part B.)

**Part A: The finding and acceptance of new knowledge**

§2. A shared theme for two different knowledge-domains

This project’s chosen topic of brain-and-intelligence led naturally to enquiries into “EPistemology” (the nature of knowledge-generally, its storage/access, and how it is acquired). But conveniently, such questions can also be readily reassigned from the brain-studies into problems of Knowledge-within-Society (i.e. to Science)

— thus encouraging a critical re-examination of doctrines about “Scientific Method”, and hence about what helps-or-hinders the acceptance of legitimate innovations.

§3. Popper and some negative impact on research-policy

Such methodological problems often relate to two details in Popper’s early formulation of scientific method in 1934 [3] which seems sound otherwise — so his account is a useful place to start the discussion.

One such controversial detail was this: He overemphasized observation as if it were the only way to “test” a hypothesis (and in a rather uncompromising way), a bias which has now too often become a mindless mantra. That climate made things difficult for Gurwitsch in the early days [4,5] — though paradoxically, that is apparently no longer a problem for ultraweak emissions which are surely so well supported observationally by now that they should have been accepted if Popper’s principles were indeed the only standard. That anomaly should alert us to look for other criteria which he had overlooked.

The other Popperian detail is that his own rules do not obey their own testability criteria (if interpreted as strictly observational in the usual way): His typical disciple will assert these rules, as if they themselves are above any need for testing or rigorous explanation in biological terms. This has relevance to the discussion of “meta-levels” which we will come to later in §5. But now let us look beyond Popper:

§4. Piaget and his added “equilibration” concept

Both “brain” and “society” knowledge-domains were much discussed by the self-proclaimed epistemologist Jean Piaget (1896-1980) of Geneva — who was also a notable biologist and psychologist, well versed in relevant philosophical writers such as Hegel and Kant. He went beyond the philosophical discussion, and considered in some detail just what “in principle” brain-mechanisms and processes would be needed to explain human intelligence and how it develops through childhood. (We shall see that the present project has sought to move further along this path, looking for actual

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1 See below, in the section on “Four Epistemologies” — §10.
2 Popper himself might well have acquiesced with these two criticisms which do not seem crucial to his own main argument. But by now that is hardly relevant. The problem is that his written-words of 1934 have become sacrosanct within many parts of the scientific community — and its funding bodies.
physiological bases for his “in principle” mechanisms such as his “schème” element as a basic unit of thought/action — leading then to those above-mentioned conclusions about IR).

Another key feature emphasized by Piaget (and largely overlooked by Popper) was that new candidate concepts, whether true or false, had to compete to fit into a perhaps-false pre-existing mind-set — and truth does not necessarily win in such circumstances. There is often a contest in which the pre-existing mind might sometimes (partly?) “accommodate” to the new idea, but it is also more likely that the new idea-or-perception will itself be somewhat modified (“assimilated”) to fit into the pre-existing mind.

This “equilibration” process of adjustment to maximize internal-agreement is clearly fallible, but it does have some positive points. Firstly it has a trial-and-error simplicity about it, allowing it to self-organize in a way similar to other biological activity — in fact it is essentially a Darwinian process, as we shall see. Secondly, as long as its conclusions are not too rigidly held (whatever that means), the mind-set remains open to further revision; and indeed competing models may often coexist. Thirdly it seems to work brilliantly for certain relatively-simple tasks such as learning the properties of solid objects (where, for instance, the infant has to acquire the surprising concept “that any rotation through 360° brings back the image I started with!!”) Fourthly, it probably works statistically as considerably better than random guesswork. Fifthly there is apparently no alternative within simple epistemological systems — and that includes the start-up phase of systems (like parts of our awareness) which are destined to become more complex and “intelligent”.

§5. Intelligence and “meta-levels”
According to both Piaget and Ashby, this intelligence starts to develop when the brain allows part of itself (some of the schèmes) to operate upon other parts instead of interacting directly with channels-to-or-from the environment (Traill 1978b/2006)[5]. This new “meta-level” (ML or M'L) transcends some of the simple Darwinian activity of the base level (L or M'L), so creating a sort of local “designer operated” situation. (As they mature, humans then go on to develop a whole cascade of these levels, and that seems to account for human intelligence in comparison to other animals where such hierarchies are of more limited scope. But note that the top level of any such hierarchy will always be unmonitored — with nothing but pseudo-Darwinian “equilibration” to guide it).

§6. The enigmatic power of “equilibration” or “making sense”
It seems then, that when we build up our concepts of the outside world, it is not enough to have observations, not even if this input is impeccably reliable. In the end we also need to be able to make some sort of sense of it when we turn it over in our minds — and this amounts to Piaget’s “equilibration”, or the “coherence-seeking” considered by some philosopher-epistemologists like Hans Albert [8](1968/1985) and Susan Haack [9](1993).4

3 For more complex tasks such as social-interaction, infants need all the help they can get, so some relevant non-trivial schemes (such as smiling, basic recognition, eye-contact, and various other “intuitions”) have evidently evolved in an orthodox Darwinian way within the species and are then usually inherited in a way which is easy to explain if these schèmes are indeed RNA-like. The occasional lack of these “prefabricated service-parts” will presumably cause autistic tendencies unless their knowledge-content can instead be learnt by that individual in a belated pseudo-Darwinian way like other less-important learning tasks — or even sometimes by instructive therapy. (Whenever such complex-basic-skill schèmes are inherited genetically, that comes close to what Kant (1781)[6] mistakenly believed to be true for the easier-to-reconstruct abilities such as our understanding of Solids-and-Space).

4 Unfortunately the word “coherence” is ambiguous within the present discussions: It can mean “self consistency of evidence ” as in a Piagetian equilibration process; but it can also mean
(That then may be why ultraweak bio-radiation has not received the public attention it deserves. No matter how impeccable the observational evidence, the trouble is that hitherto it has *not seemed to make much sense* — and that is where the later parts of this paper might start to help, at least for the case of IR-around-nerves. UV is probably a separate issue relating to the control of mitosis, &/or some *special* brain activity,5 and if we can ensure that such UV also “makes sense” then no doubt the scientific world will become much more interested in it too.)

§7. How could such a system ever get started?

Pure “sceptical” philosophers like Hume (1748)[12] have long had misgivings about the whole epistemological exercise, because it has seemed to them to be a theoretically impossible task to accumulate knowledge if one starts unaided from nothing!6 The start-up enigma is that any recording-or-interpreting mechanisms will have some knowledge already implicit in their structure, so these cannot be allowed in any genuine start-up system (according to the more-rigorous philosophers). So how could such a system have coped usefully with incoming information? (This dilemma is akin to asking how life can be reproduced unless we start with a living system — and indeed we will see that this is no mere analogy, but a special case of the same thing if we accept that “ability to conduct life” is a form of knowledge).

The “start-up” answer probably lies in the fact that all systems which actually survive “long enough” (whatever that means) will have one thing in common — their *dynamic stability*, and that can be interpreted as “internal coherence” or “some measure of equilibration” or “a sufficiently self-consistent pattern of mutual attractions in real or virtual space”. That means that when arbitrary signals about some “observed” environmental system are received by a “start-up brain”, that brain will manipulate those signal-traces somehow, and sometimes arrive at some dynamically stable internal configuration using them. That stability, when it occurs, will offer a workable chance of capturing some feature of the “real” setup outside. Well, that may not sound like much, but it does offer a toehold which could have allowed the process to get started — and from there (like life) it might well escalate significantly.

That is an argument which may suit biologists. However philosophers are seldom used to thinking in terms of dynamic systems dependent on Darwinian trial-and-error, so they tend not to see coherence as a fully respectable solution to their epistemology-enigma. They do nevertheless sometimes consider it seriously while they continue to look for something more tidy and “logical”, or just bemoan the absence of such neatness.

§8. Even then, how is further knowledge-acquisition possible?

In 1968 Popper himself offered a helpful two-page summary of his 1934 book [3] and its objectives (as the preface to its third German edition) — affirming that it was indeed theoretically possible to get

5 *Note this interesting difference:* In the peripheral nervous system (PNS), myelination does not start until the axon-diameter reaches 1μm — implying a possible association with NIR having wavelengths \( \approx 2\mu m \). However myelination within the central nervous system (CNS) sometimes starts at much smaller diameters (see images in Peters et al. [10]) which suggests a significant presence of UV, though that may just be a byproduct of UV activity unrelated to neural transmissions; — see §8 below, and [11] §5.1.

6 *This start-up (ideally a once-only affair) does not refer to any present-day real brain (which clearly does have some inherited abilities) but rather to either (i) hypothetical new start-up situations envisaged legitimately by philosophers, or (ii) whatever it was — countless generations ago — which did actually initiate brain-like activity and the inheritable structures which encoded it. Likewise in the social domain the real case does not refer to present-day society, but rather to some start of collective knowledge-and-language (before stone age society evolved).
increasingly closer to the truth, but (as in the previous paragraph) we should not expect perfection. Thus, for instance:

“The answer is not pessimistic ... or 'sceptical' ....: It shows that we can learn from our mistakes”. NB: (i) Like Piaget, he invokes trial-&-error (and doesn't that mean “Darwinian”?) but (ii) unlike Piaget, he does not really ask what further mechanisms are required in the learning process. Instead he effectively just takes these for granted (as we all tend to do) — thus overlooking the power of equilibration/coherence.

Interestingly, he then admits to finding out subsequently that his outline (of how epistemology must operate) was already 2500 years old — having been put forward by Xenophanes, whom he then quotes!

§9. Darwinian “Trial-&-Error” or Lamarckian “Instruction”

In 1967, the immunologist Niels Kaj Jerne[13] offered an interesting insight into the knowledge-acquisition process in general — (My italics — and quoted previously [14]):

“Looking back into the history of biology, it appears that wherever a phenomenon resembles learning, an instructive theory was first proposed to account for the underlying mechanisms. In every case, this was later replaced by a selective theory. Thus ... species [as divinely designed] ... until Darwin...

Resistance of bacteria [purposively! reconfigured] ... until Luria and Delbrück...

Adaptive enzymes [purposively! reconfigured] ... until Monod and his school...

Finally, antibody formation [in immunology]...” — [the actual topic of Jerne’s paper].

On reflection, that simple selection-of-what-actually-works must surely be true for any natural epistemological system in its start-up phase (when it cannot yet have acquired any means whereby it can be “instructed”). Later on, it may have the choice, but “trial-&-error” may still remain preferable for various reasons — such as avoiding the intellectually-difficult and costly maintenance of designed equipment (hence the development of “throw-away” modules which can sometimes be used in a trial-and-error fashion despite being “high-tech”!)

Yet of course, once we have developed human intelligence (see §5 above), we are free to operate in a Lamarckian way: to create innovative designs, and pass them on for others to use. One minor problem is that we may then fail to recognize the existence or value of Darwinian processes when they occur. Or more seriously, we adults may be so familiar with our own advanced abilities, that we do not notice any mystery at all in how we achieve these abilities. Thus (e.g.) if we “see” something, then “obviously it must be true” — and usually it is, but not always (as optical-and-other illusions tell us) and then we may just dismiss it all as a weird anomaly. That is where careful attention to Piaget’s analyses of childhood mental-development can be useful and instructive — helping to protect us from complacent assumptions about our own “mystical otherworldliness”.

§10. The four knowledge-gathering domains

Inspired by Jerne, Popper (1973)[15] identified four main types of epistemological system: (a) The Brain of the individual; (b) Jerne’s immunology; (c) Classical Darwinian species-evolution with the knowledge stored within DNA-coding; and (d) Society-as-such including its scientific knowledge, separate from individual brains.

(I have already discussed these four domains at length, so I shall be brief here; but see [16] especially Table S on page 31, and [14] Chapter 4).7

7 Respectively http://www.ondwelle.com/OSM02.pdf and http://www.ondwelle.com/BK0_MU6.PDF .
Note firstly that since the epistemological task has been recognized for some 2500 years as “almost impossible”, and that only one formal solution to the problem has ever been discovered, it seems likely that all these four domains will be using that same formal strategy even if other details are very different. Thus, taking the “true-Darwinian” case (c) as our bench-mark (since it is the one most thoroughly understood), we now seem entitled to claim that all four domains will be dependent on Darwinian trial-&-error — at least at start-up.

We might also expect uniformity in some of the details which accompany this strategy, such as the need for largish populations (often including replications) of assorted “candidate-recipes-for-action” from which to select — more-or-less randomly. Then also note that ultimately such recipes are usually in the form of linear coding (like writing) in cases (b), (c), and (d). So what about the brain, case (a)? The text-books favour some arcane configuration of synapses acting alone as in Figure 1 below — but that does not offer much scope for organized linear coding, nor indeed much scope for stable digitized code, another apparent requirement for knowledge. So can we suggest something more in line with the (b)-(c)-(d) cases?

It is clear that Piaget’s simpler schemes entail a linear narrative of action.8 These schemes thus offer a suitable match to the (b)-(c)-(d) cases — (though no doubt the synapses still have their own role to play, perhaps mainly as analogue components, e.g. “directing traffic” and/or “volume control”, and most crucially providing input and output links to the outside world). Meanwhile though, the new Piagetian interpretation is one key to our discussion of IR emissions in Part B, below — where the scheme is considered as being an “RNA-like” molecule.

Differences between the four domains? Certainly some of the other details are very unlike — notably the time-scale and the physical embodiment for the various linear recipe-types — but these differences need not matter as they do not affect the formal requirements; — [16], Table S again.

§11. Coherence — “internal” and “external”

We can think of encoded knowledge as a model supposedly representing significant aspects of the world “outside” — though much more accessible than that world, and also offering opportunities for the comparatively-harmless testing of “new ideas” or “mutations” or “sensory perceptions”.

In the Pure Darwinian/DNA case, (c), survival certainly depends partly on achieving a model (within the phenotypic body-configuration of the individual) which matches the demands of the environment. Likewise in “(d)”, Popper’s criterion (that a hypothesis should survive experimental testing within the “real” world) also has some validity. But in neither case is such external-testing the whole story:

In “(c)”, an embryo whose organs are not properly configured and interrelated internally will probably be aborted prematurely long before it is tested in the hostile outside world. That is a failure of internal consistency or “internal coherence” — and it is surely a vitally important type of test. Indeed when life first evolved, this would probably have been THE most crucial test, given the temporary absence of competitors or predators. Moreover getting organelles to be mutually beneficial by trial-&-error means would be no small feat — never mind environmental complications (apart from sources of energy and supplies of “arbitrary building materials”).

Concerning “(d)”: When Popper wrote about “testing” he was clearly just thinking about the external (experimental) type of test. I suggest that this was a mistake, and he should also have allowed about half the tests to be “thorough tests of internal consistency” — i.e. tests of internal coherence —

8 — and his more complex schemes are ensembles of those simpler schemes, linked in a way which is also arguably controlled by “higher level” simple schemes; [7] Part C.
tests for whether the ideas actually made sense within a dynamic whole.\(^9\) Note that it is important to clarify this point here, because Part B (below) depends heavily on this theoretical tool — given that it is enquiring into mental/neural phenomena which cannot currently be investigated directly by experiment. Later the research-possibilities might change somewhat, but it is necessary to establish a plausible *prima facie* case first — and that can only be done via internal coherence, using all the background interdisciplinary understanding we can muster.

However we should recognize the original reason for this twentieth-century bias against theory and internal-coherence arguments. *In the social sciences*, there can be no such thing as a fully-reliable base concept — and even if there were, the outside world would probably soon change thus spoiling that reliability. It is nevertheless still prudent to consider (collectively) such concepts as “altruism” and “the marginal propensity to consume” to help guide our planning, as long as we remain aware of any vagueness and obsolescence of such ideas. However there are countless examples of overconfident politicians etc. who have taken some social formulae as immutable and infallible, and created havoc thereby. Pol Pot, some current financial “experts”, and Robespierre all come to mind.

In contrast, the theory of “what underlies chemistry” started like that, with medieval alchemy; but it then progressed through a series of remarkable theoretical developments: • The periodic table; • Chemical formulae with countable atoms; • The Bohr/Rutherford “orbit”-model of the atom; and • The Bohr/Schrödinger “wave-function” model of the atom. The key to such progress largely lies in improvements in identifying what the most basic elements seem to be (and how they interrelate) — even if they end up as the enigmatic mathematically-defined “ψ-wave” of Schrödinger’s theory. The key point is that this can be very precisely conceptualized, giving us a very clear model of the hydrogen atom at least — a model we could never match by purely experimental means. And the consequences of this discovery have been immense.

**§12. Rethinking Popper’s Scientific “Tests”**

Popper treated hypotheses as if they were random mutations in a Darwinian environment, though he may not have recognized this explicitly. He did say, on at least one occasion, that it *did not matter where the hypotheses came from* (as long as they were testable), and that looks very much like “random mutation” about to be tested by reality. Of course this has some validity, but it raises at least two points:

Firstly, such extreme sudden-death testing is characteristic of those “start-up” Darwinian situations before the learning-system has any other guide-lines to help it — survival of the supposedly *fit* — but with “fit” considered unrealistically in absolute terms.

In real life, “fitness” may be a more messy concept, for which gradations and statistics may need to be applied. Biologists consider “survival of the fittest” within a competitive world, whereas philosophers like Popper tend to seek *“perfection-or-nothing!”* That may be fine for simple problems, but note that in the above-mentioned history of chemistry, there was a whole sequence of not-quite-right partial truths — and without these, the apparently-right answer would never have been reached.\(^10\) Moreover that does look like Darwinian evolution “(c)” within this new domain “(d)” — and more so than in Popper’s prescription for that “(d)”.

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\(^9\) He could also have considered how one might work with conflicts between such evidence — a matter I will not go into here, but see Thagard’s book on such matters; [17], or his website.

\(^10\) Intermediate advances can, for instance, help clarify what the basic elements of the problem might be — and that, in turn, might convert an apparently-complex problem into a simple one which would (at last) accord with the philosopher’s demands!
Secondly, (as we have seen above in §7), tests of the *internal coherence* of hypothesis-concepts can be just as relevant as Popper’s observational testing. Thus in general it seems prudent to aim for an equal balance between the two, but this should probably be varied according to circumstances. Currently there is an oversupply of observations in most fields, and a dearth of coherent explanatory theories\(^\text{11}\) — so it seems timely to concentrate on the latter for the time being, especially in the present brain-intelligence project where no adequate direct observations seem possible.

(Moreover if there is any doubt about the boundary between the “internal” and “external”, then we might even question whether there is a fundamental difference between plain “coherence” and “agreement with experiment”. In a sense they are both coherence-tests, so I sometimes name them “internal coherence” and “external coherence” respectively.)

Anyhow, it seems appropriate to suggest that Popper’s meaning of “test” should be extended to include tests for “internal coherence” whenever appropriate — but with safeguards to prevent too much reliance on it whenever the basic concepts are vague. Of course, in many fields the basic concepts are vague, at least temporarily. That is part of the problem, and that is why it seems so important for progress in psychology to find out what exactly a Piagetian “schème” really is in physical terms — and what its communication system must be. That indeed is the *raison d’être* for the current project, especially Part B below.

### §13. Seeking a physical embodiment for Piaget’s abstract “schème”

This project’s chosen topic of *brain-and-intelligence* led first to some philosophy-related enquiries into “EPISTEMOLOGY” (the nature of knowledge, its storage/access, and how it is acquired) — and such epistemological issues have been discussed above in *Part A*.

For instance, *Part A* introduced Piaget’s concept of the “schème” (as the supposed basic unit of thought/action) and how we may provisionally think of each simple schème as linear digitized coding (like writing or computer-tape). By elimination, that schème must apparently be an *RNA-like molecule*. (Whether or not it is actually RNA need not concern us at this stage, though the evidence points strongly that way).

Anyhow, here within Part B we will revisit that argument *from a more biophysical viewpoint*, and explore some logical consequences of that “RNA-like” conclusion, especially asking about meaningful communication between such ultra-micro sites and other parts of the nervous system. In broad outline, the argument follows the downward path through this icon-diagram:

![Diagram](discussed in Part C)

Such theoretical work raises another epistemological issue, also discussed in *Part A*: Thanks to Popper and his disciples, *theoretical treatments* have been regarded as “*not to be trusted at all unless corroborated*”; and that qualm definitely has some justification when the underlying concepts are vague, as in the social sciences. In the present case however, the systems being studied are mostly small enough for them to be described using physics and information-technology — disciplines which have largely defeated the vagueness-problem, and therefore do allow us to make significantly reliable theory-based progress. If we can next test such conclusions experimentally, then so much the better

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\(^{11}\) Sir Francis Bacon (1561-1626), said to be the “father of observational science”, long ago predicted such pendulum swings between the two biases; (Bacon 1620[18]; also [14] endnote b, p.98).
(see the “♠” marks throughout the text)\textsuperscript{12} — but many details of such ultramicro ensembles will probably always defy direct observation, so we may sometimes have to content ourselves with the theoretical solutions anyhow!

\textit{A sketch-outline of the arguments invoking “molecules+IR”}

We can now look at aspects (1)-(4) of molecular-memory theory, partly illustrated by interactions between the layers \textit{i-iv} of the above icon diagram which will appear several times:

(1) Apparent \textit{molecular}-solutions to some enigmas within Psychology, — layers \textit{i-iii};

(2) Problems of communicating with such sites. IR as the only feasible solution, layers \textit{iii-iv}.

(3) The surprise finding that existing myelin could have a second role as coaxial cable for IR!

(4) Some other surprise findings (including other areas) derived logically from these.

\textbf{(1)} \textbf{The Memory-code Enigma in Psychology: — the first steps}

— \textit{i.e. the advanced thought-ability of humans},

including details of its self-organized development?

\textbf{B(1) – §14. What actual mechanisms could possibly explain thought?}

Orthodox physiology focuses on the observable activities of synapses and their electrical “action-potential” signals. This conventional view is that thoughts are \textit{somehow} encoded and marshalled by means of neurons and their synaptic connections — as shown schematically in figures 1\textit{a} and 1\textit{b}, (though of course it has been recognized, at least since the 1960s, that actual neurons are usually much more complicated).

These synaptic arrangements are obviously relevant and they do explain \textit{some} phenomena such as “pattern recognition” abilities — but no-one seems to know how to use such elements to explain \textit{advanced human intelligence} except in vague terms. In particular, if these are the \textit{only} available mechanisms, just how could they store the encoding for a remembered Shakespeare sonnet, or a mathematical theorem, or how to play tennis strategically? — And there are the added insoluble(?) problems of actually \textit{encoding} such thoughts initially, and then separately \textit{retrieving} them at appropriate times; etc. — not to mention the biological need for such systems to \textit{self-organize} during development.

\textbf{Fig.1} The text-book view of \textit{bio-memory} mechanism. These schematic diagrams illustrate the traditional approach. However this is simply not adequate (on its own) for explaining human intelligence. Instead we need to consider a \textit{molecular} arrangement (as suggested in Fig.2).

\textsuperscript{12} I have used “♠” in the text to indicate \textit{points} which \textit{now seem to be testable-or-retestable experimentally}. These items are listed in the Appendix (§33), which summarizes the apparent possibilities at this stage.
Moreover it seems that these are essentially just analogue devices (at least in their more realistic complex form), whereas intelligence surely requires **digital** capabilities — so we need to seek some additional memory-mechanism which is digital (AND capable of *neat sequencing*):

**B(1) – §15. From analogue-neurons to digital “instruction-lists”?**

This is where Piaget’s “schème” concept can be offered as a semi-solution. — In Piaget’s own work, this *schème* (an idea modified from Kant [4]) is an *abstract* entity embodying a mutatable *unit of action*, from which we humans can gradually build increasingly sophisticated concepts; ([5], espec. §C5.2).13

One key innovation here was to move our focus away from the mind’s concept of *nouns like “chair”* and onto *verbs like “draw”* — suggesting that our initial concept of “chair” is a gradually assembled ensemble of schèmes for ●drawing, ●outline-tracing, and ●sitting, etc. That led to a mass of epistemic-and-psychological theory which we can bypass here; but it seemed that Piaget’s “schème” would probably have to be encoded in **linear 1D** form, as strings of **digital** “beads” — all very similar to list-like elementary computer code, or a string of verbal instructions. Anyhow here, in Fig.2, are some diagrams building on this 1D approach.

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13 Those readers who happen to be familiar with “machine code” or other “low level” computer programming, will no doubt recognize an analogy with the “*sub-programming*” technique — with the simplest, lowest level subprogram coding being analogous to the simplest, lowest level Piagetian schème. That comparison is useful, but of course it is important not to take such analogies too far.
B(1) – §16. But what could these abstract “schèmes” be physically?

There seem to be only four or five plausible candidates for such linear-digital structures: ●DNA, ●RNA, ●PNA, ●Protein; — (and in principle such a service could also theoretically be provided by unbranched rows of dendrite-free neurons within relevant local parts of the brain — but there seems to be no evidence that such rows exist, and they would surely be grossly inefficient and digitally-unreliable if they did). So, by elimination it seems that the basic elements of advanced thought must be RNA-like, thus constituting the (still hypothetical) “[R]” system — operating in parallel with the traditional “[A]” system of neurons and synapses which probably offers essential analogue-adjustment and support.

Hence Hypothesis 1: That important components of human memory-coding are embodied in linear macromolecules such as RNA-or-DNA.

(— Difficult to test except by its implications)\(^{14}\)

\(^{14}\) There is no clear direct lab-evidence for this memory-code method, (so indirect instead?) but it does have a sound logical basis — and its consequences are encouraging: One unforeseen \(\textbf{\#bonus}\) is that it allows us to bypass the very awkward question of how such memories could be “written down” — i.e. “where is the ‘tape-recorder’?” In fact (as we saw in Part A) the likely answer lies in \textbf{Darwinian trial-and-error} amongst the vast populations which must be available (thus avoiding the Lamarckian “tape-recorder” altogether). Another \(\textbf{\#bonus}\) arose externally when Mattick [21-24] made it clear that only 3% of human RNA was needed for its traditional role — leaving 97% available for other tasks (such as memory-coding perhaps?)\(^{14}\).
For our present purpose (as mentioned above), it probably matters little which type of molecule is involved — so we can be content just to say “RNA-like”. But whichever macro-molecule it is, we run into a complication which turns out to be instructive:

(2) **Fast-“talk” needed between memory-sites? — IR or what?**

B(2) – §17. **Action-Potential Pulses as far too crude for Digital Sites:**

Ordinary molecular bioprocesses involve energy jumps of about 0.5 to 1.3 eV — with a wave-period of 8-to-3 femtoseconds (10^{-15} sec.)\(^{15}\) — clearly in the near infrared range (NIR), and potentially available for local “broadband” signalling if organized correctly. So it seems likely that any molecular memory-coding will come to use this NIR medium, for local communication at least. And if there is also “neuro-talk” via the well-known action-potential spikes, then so be it! There is no law here against bilingualism!

However we should be clear about the contrast: Several femtoseconds for a NIR wave-cycle, against the millisecond action-potentials. Thus we see a mismatch-factor of more than 10^{11} (or perhaps only 10^{9} to be conservative)\(^{16}\) — like contrasting “today’s internet-electronics” against “a morse-key of the 1850s”.

(Of course we all know that the millisecond “morse-key signals” do exist in nerve-fibres, whereas the evidence for NIR neural-signalling is only indirect (♠) despite its vastly greater theoretical capacity. — Yet surely the nervous-system needs all the “bilingual” help it can get from whatever mechanisms are bio-feasible, as long as they can work together. Thus, for instance, it is quite likely that one major role for the action-potential system “(1)”, is to offer an “analogue” service which fine-tunes and marshals the activities of an NIR “[R]” system, and thus refines the rapid digital activities at RNA-like sites.)

In any case, it is difficult to see how the comparatively clumsy action-potentials could offer a sufficiently fast and precise broadband network. And any molecular memory-system would surely need this broadband precision, since only then would its digital RNA-like sites be able to talk efficiently among themselves.

Hence **Hypothesis 2**: That if bio-molecular memory-coding exists, its chief channel for fast communication will be via NIR signals.

In other words, we are considering photons as potential message-carriers for advanced intelligence activity — normally replacing the action-potentials altogether whenever we are dealing with “conversation” which is amongst molecular sites exclusively. Indeed there seems to be no other plausible possibility for fast communication,\(^{17}\) (though chemical diffusion does offer a slow alternative “postal” service). Anyhow **Figure 2** shows such IR activity (colour-dots) added to the bare 1D molecules (the “strings-of-beads” in grey/black).

\(^{15}\) With corresponding wavelengths of 2.5 to 1 μm, assuming travel at the velocity of light in vacuo. (See [25: “Clue B”: now online as www.ondwelle.com/OSM10en.pdf].)

\(^{16}\) E.g. to allow for many cycles within each photon.

\(^{17}\) What Evidence can there be here if direct observation is not feasible? Consider this:

- **BY ELIMINATION**: The IR solution seems to be the only explanation which fits with all the constraints.

- **BY ITS USEFULNESS**: It also leads to unexpected solutions to enigmas in other fields — discussed below in sub-part “(4)” — §23-§27.
Can we identify Paths for such IR communication?

B(3) – §18. Direct Short-range through Watery Media
This is possible, though limited to about 20μm before it is absorbed (depending on the actual frequency). That should suffice for many intermolecular tasks and for adjacent cells. However fatty media such as myelin offer much better prospects:

B(3) – §19. Long-range through Myelin (acting as an optic fibre)?
This too seems theoretically possible, since myelin is effectively the dielectric within a coaxial cable (bounded inside and outside by conductors, like any TV coaxial though much smaller as befits the much shorter wavelengths involved). §22 shows pictorially how this might work — but first:

Digression to explain Transmission-Modes within Coaxial Cables

B(3) – §20. The TEM mode of wave-transmission
This is the “straight ahead” transmission-mode for light in free-space — with both Transverse vectors for both the Electric vectors and the Magnetic vectors. But it can also occur between two separate conductors:

Fig.3. TEM waves travel through the dielectric (e.g. myelin) between two different conductors in each case

This “straight-ahead” TEM mode is what engineers usually strive for — but biology has different priorities and constraints, which might allow (or even favour\(^{18}\)) “zigzag” modes, as depicted in Figure 4:—

\(^{18}\) Optical dispersion amongst the different frequency components within the brain might usefully (i) help allocate signal-types into various dedicated paths — &/or (ii) transform signals in a repeatable way such as to suit (by trial-&-error?) stringent pre-set requirements of locality X (but no others) — a form of tuned reception if it actually works. (Traill 1978b[7], §C6.7).
B(3) – §21. Zigzag modes (e.g. “TE\(_{1,0}\)”)
— a frame for external standing-waves

One relevant point here is that non-TEM waves — with a sideways component — may (i) occur weakly in the initially-bare watery axon, despite significant absorption by water; (ii) readily leak out and (intermittently?) set up a standing-wave pattern around the nerve-fibre. (iii) This would tend to create alternate concentric energy-filled-zones, and energy-free-zones or “moats”. (iv) As we shall see, myelin (a good dielectric) may then be likely to grow within any such energized zone, until reaching the low-energy “moat” — as a new coaxial.

End of the Digression
B(3) – §22. Myelin geometry — its likely “transmit+broadcast” ability

Note that orthodox action-potential signal travels in one direction only (downwards in Fig.5) and it does not stop at the nodes-of-Ranvier (despite their “refuel” importance) — so its role could be compared to an express train on a one-way system between “cities” (cell-bodies).

In contrast, it seems likely that IR signals (if they exist) would be more like a “two-way stop-on-demand service between “small villages” (nodes-of-Ranvier) — and also between adjacent sites, whether near the node “station” or simply near each other. See red arrows in Fig.6. In any case, it would probably be worthwhile now to study the geometry of such sites more closely, bearing in mind their possible optical and “radio aerial” properties.♠
(4) Neural-IR (if true) offers Surprise-Solutions to Problems

Here is a list of five serendipitous theoretical solutions to problems in other areas, arising from the above theory. Perhaps we might also add the two “bonus points” (”♦”) listed within footnote 14.

1a. B(4):§23. Myelin Geometry

How thick will the myelin be? (see Fig.7, below). As Donaldson & Hoke[28] noted in 1905:

\[
\text{Area of grey annulus (myelin) } \approx \text{ Area of central circle (axoplasm)}
\]

And this implied  \(\frac{m}{r} \approx \frac{4}{14}\)

Fig.7. Plotting the geometry of axon+myelin cross-sections.

The most hypothesis plus the subsequent reasoning together predict that the \(\frac{m}{r}\) ratio will mostly take on a small “quantized” repertoire of values.

Each such value is represented by a straight line through the origin — here shown as dashed lines, using fictitious values.

From [14]; Fig 7:7, page 54. www.ondnelle.com/BK0_MU6.PDF

Fig.8

One set of actual \(\frac{m}{r}\) values

Data kindly provided by Boyd & Kalu

Note the faint trend toward a straight line below-then-amongst the scatter (left-to-right), favouring

\[\frac{m}{r} = 2 / 6.5\]

i.e. \(\frac{m}{r} = 0.308\)

Note the high resolution.

There were also two other such plots, Boyd & Kalu,[29] but more are needed ♦

Adapted (by axis-swap) from [14], Fig 6:3, page 42.
So now, applying IR theory, we come to:

1b. B(4):§24. **Mechanism? —Plausible Myelin control via IR**

**Hypothesis:** That myelin growth tends to be encouraged by IR standing-waves around an axon — and tends to stop when the wave-field intensity vanishes (or falls below some threshold).

**Fig.9a. POSTULATED TRANSVERSE STANDING-WAVE ACROSS AXON producing \(\Rightarrow \) **MOATS** AT NODES**

![Diagram](https://www.ondwelle.com/BK0_MU6.PDF)

**ALSO Fig. 9b.:**

![Diagram](https://www.ondwelle.com/BK0_MU6.PDF)

2. B(4):§25. **Why PNS myelination is delayed until axon diameter \(\approx 1\mu m\)**

The likely reason for that constraint on the peripheral-nerve development should now be obvious from the above diagrams. The \(1\mu m\) would correspond roughly (given the circular geometry) to the half-wavelength which forms the basis for the loop at the centre if the concentric pattern.♣
For the central nervous system (CNS), much smaller early-myelination diameters are observed, and that could be taken as a sign of consistent UV presence, though it is not suggested that UV could actually be transmitted effectively along myelin paths. (The mere “reliable” presence of UV for whatever reason, would suffice — and presumably these conditions are not to be found in the PNS).♠[11]§5.1, and see footnote 5 above.

3. B(4):§26. Why Myelin often stops its “wrap-around” near where it starts?
   — The “Quadrant” enigma of Peters[30] and Webster [31]; — [11]
   — Explicable if we consider the myelin as filling up the annular “virtual” space around the axon (due to IR standing-waves). Thus:

4. B(4):§27. The missing Action-potential when insects “see” IR signals
Callahan [33] showed that his insects were responding to IR — but he could not detect any relevant action-potentials!
The plausible solution is that the IR is received directly into the insect nervous-system, without the need for inefficient “translation” (of IR→Action-potential→?IR). [34,35]

5. B(4):§28. The surprising efficiency of the optic nerve
An apparently inadequate channel capacity (for action-potential signals, [36]) might actually have much more “broadband ability” if seen as having fibre-optic properties.

Part C: Piaget + IR + Gurwitsch = Corroboration & Coherence?

§29. Scientific corroboration as “Social Equilibration” or “Coherence”
Paul Thagard [17] gives several historical examples of complex scientific problems — and how they were eventually solved with the aid of a search for coherence amongst the often-prolific evidence. In particular he details the coherence-patterns eventually offered within the revolutionary ideas of Darwinian theory (Ch.6, p131+), Continental drift (Ch.7, p157+), Gravity (Ch.8, p191+), and the simpler case of Oxygen-versus-Phlogiston (§3.2, p39+).

Such coherence-amongst-our-ideas19 is all very well in retrospect, but it may be far from obvious while one is actually engaged in the original investigation — or only “apparently obvious” regarding some small part of the problem at any particular time as the project progresses.

Meanwhile there is the danger that such parochial conclusions will be inaccurate or misleading, so our goal should be to get well beyond the parochial into some sort of large “jigsaw-puzzle” where all the relevant evidence will somehow “fit in” eventually. — There is apparently no royal road to achieving that systematically, but we can-and-do find apparently-relevant pieces or sub-assemblies and try to fit them into that jigsaw-puzzle. (And isn’t that just social epistemology at work, seeking equilibration amongst candidate “schème-analogues”?)

So now, regarding weak bio-emissions and related phenomena largely overlooked by mainstream science: Perhaps it is time to take stock of whatever semi-complete bio-physical “sub-assemblies” are now at our disposal, and try to fit them together into a bigger collective system — a new attempt at a bigger multidimensional jigsaw-puzzle with much more overall coherence which would offer a more persuasive case if the internal coherence does indeed exist. In any case it seems important that we investigate the situation:

§30. Ultraweak IR and UV observations:
— One(?) “sub-assembly” of ideas?
As mentioned in §3, these experimental findings (Gurwitsch, 1923…[1,2], etc.) were often simply not believed in those early days. Improved methods and many further investigations have nominally changed that — notably with contributions from Fröhlich, and F.A.Popp, and with publications such as “Electromagnetic Bio-Information” [37]. But as this body of work has not yet been taken very seriously by mainstream science, it may be fair to identify it (as it stands) as a ”sub-assembly” which might well contribute

19 At the same time, the actual dynamic system under study must necessarily have enough physical coherence to hold it together — at least long enough for us to study it (as discussed above in §7). One trouble is that we may initially have no notion about what causes such physical coherence in the various cases.
to some future general enhancement of our ideas about cell activity.

Here I take the liberty (at least provisionally) of dividing this sub-assembly into two — distinguishing between IR and UV emissions. For one thing, the above discussion of the nervous system had identified IR as a likely participant, but it had very little to say about UV — indeed the gross optical peculiarities of those different bands are notably different. Secondly UV photons would be much more dangerous if misplaced (with about ten times the energy which would also entail special logistical complications)[38,41]. So graphically, I offer two iconic “tiles” to represent these two “sub-assemblies”, but on this occasion I shall use only the IR case, (though still referring to its icon as “G” as if it were the only one!).

§31. **Two “sub-assemblies” arising from Psychology and Neurophysiology**

*Part B:* provided the discussion of Piaget’s theory (§13–§15) and then its apparent *molecular* (§16), and *IR* (§17–§22) requirements. That progression was symbolized by the four-layered icon which is now labelled as “ψ”: Of course each layer could be offered as a separate minor sub-assembly, but it is only when they are brought together that they offer significant collective coherence as an idea.

The next advance, “B(4)” (§23–§28) was to seize the windfall opportunity of further coherence which provided unexpected solutions to problems in other areas. — That takes us to the yellow “Neuroanatomy” icon, which can now be referred to as “N”. This sub-assembly offers a degree of parochial coherence on its own (e.g. suggesting that growth might be controlled by IR even if that IR had no other role such as in “ψ”) — but clearly it makes a more compelling-and-coherent case if the two sub-assemblies N and ψ” are envisaged as collaborating via IR.

§32. **Assembling the (incomplete) jigsaw-puzzle**

This “three walled cube” is not necessarily the best fit, but it offers a useful talking-point. G approximates “pure experiment” while ψ approximates “pure theory” — in which case we may seek to find suitable links between them, and to some extent N seems to fill this bridging role. Further evidence would clearly be welcome, and closer study of such configurations might help us choose future areas of enquiry — e.g. how to extend-and-integrate the accompanying theorizing about ultra-violet (UV), [41].

Meanwhile we might hope that such enhanced coherence will focus serious attention on such enquiries. That could lead to significant advances.

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Appendix: List of Suggested Experimental Investigations

§33. These items, (marked “♠” within the general text) seem worth considering for some sort of experimental testing; and at first sight each such test-type seems feasible, though maybe expensive. I accordingly invite those with the relevant resources to investigate them — with or without my collaboration, though I would appreciate information about any such developments.

| § | footnote | Description of suggested area for experimentation, marked “♠” in the text |
|---|---------|------------------------------------------------------------------------|
| 1 6 | 14 | Lab-tests for RNA-like memory-coding? E.g. Re-do Hydén’s work, but with RNA now seen as a likely coding-medium in its own right — mostly independent of any synaptic-coding enigmas. Traill (2000[39], pp.45, 53), Hydén (1967[40] and his other works). |
| 1 6 | 14 | Of Mattick’s 97% genetic ncRNA.s:— Do some serve as raw Piagetian “schèmes”? |
| 1 7 | — | Can NIR neural-signalling actually travel optically through myelin? And if so, can we use its principles to design test-probes for further investigation? |
| 2 2 | — | Re-study the Nodes of Ranvier, checking for optical (radio-aerial) significance |
| 2 3 | — | Replicate and extend Boyd & Kalu’s scattergrams ([29]; plus Fig 8 within §23 (above).) |
| 2 5 | — | Suppose we impose unnatural wavelengths at myelination-sites, will that cause myelination to start at some unusual “critical” diameter in the growing axon? And if so, is that new diameter ≈ half the imposed wavelength? |
| 2 5 | — | Is there actually any connection between “early” CNS myelination and any presence of UV? |
| 2 6 | Fig 11 | Devise false virtual-“moats” to see whether that affects the eventual myelin properties |
| 2 7 | — | Are IR signals received directly into the insect nervous-system non-chemically? And is chitin (instead of myelin) important as a dielectric conduit for IR in insects? |
| 2 8 | — | Can the optic nerve transmit photon-signals? — If so, what wavelengths? And might this have “broadband” implications regarding that nerve’s ability? |
| — | — | Systematically collect and collate more-exact wavelength details about ultra-weak IR emissions |