A 21st Century
MONADOLOGY
or
Principles of Philosophy

A 300th anniversary recasting of,

and tribute to, the text of

Gottfried Leibniz

1714

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Introduction

In 1714, towards the end of his life, Gottfreid Leibniz wrote a short, concentrated summary of his view of what our world is about that came to be known as the Monadology. The Monadology is regarded as one of the classic texts of natural philosophy but it has also often been seen as inaccessible, fanciful, and out of date. The reason for offering a twenty-first century version here, 300 years on, is that, in my opinion, nothing could be further from the truth. Leibniz's Monadology has a claim to being as clear, cogent and contemporary as any attempt at a comprehensive world-view yet written. Some adjustments to his practical interpretation need to be made, and that is an essential part of the current project, but I doubt that any other proposal is a better starting point. So in very simple terms, the purpose of this project is to try to tempt those interested in what is really going on in the world (by no means just 'philosophers') with the idea that Leibniz's recipe may be a useful and inspirational guide.

To be specific, Leibniz's central idea was that our world is constituted not by 'extended matter', nor by 'ideas' but by dynamic units of what we might now call energy. This simple message, which is very close to what modern physics would say, has been obscured by commentators convinced that Leibniz was proposing some strange supernatural realm, outside space and time. As I see it, words like non-physical or supernatural have little or no place in his ideas.

What is probably true is that unless one has already explored the inconsistencies to be found in the intuitive 'folk materialist' view of the world (that seems to be even more popular now then it was then) in the way that Leibniz did, Monadology can seem very abstract. However, once familiar with where he is starting from the text is clear: Leibniz is dealing with fundamental issues of physical science in a way that has time after time proven to be right. He is also dealing with the nature of experience and subjectivity, and he wants to combine these with physics in a seamless whole.

As Richard Arthur addresses in his *Leibniz* (2014), the accusation that Leibniz is fanciful or 'metaphysical' in a perjorative sense is simply a reflection of the academic philosophical community's inability to understand Leibniz's agenda. If anything Leibniz is the most cold-blooded of all natural philosophers, for whom there is only one sort of 'goings on' in the world. When Bertrand Russell (1900) said "In this passage the unduly practical nature of Leibniz's interest in philosophy very plainly appears" he seems to have been blissfully unaware of the irony of the word 'unduly'.

Leibniz's account is only metaphysical in the sense that metaphysics is the business of getting your basic concepts right before you try to build a 'physics'. Neither the monads, nor indeed God, are 'outside physics', or outside space and time, for Leibniz. He was writing at a time when 'God' was still an accepted term for whatever was the real explanation for everything. He saw himself as a Christian but the fact that one of his major projects was to re-unite the Catholic and Reformed Churches suggests that he was not tied to faith in a particular church doctrine. He wanted to base his idea of the real explanation for everything on the evidence manifest in the regularity of events, not miracles. If anything, there are fewer 'magic ingredients' in Monadology than in his contemporaries. It is Spinoza who says the mind is the 'idea' of the body, with no explanation. It is Newton who proposes an absolute space, like some invisible graph paper for matter to move on. In comparison Leibniz is ruthlessly minimalist. And yet that does not stop him dealing with the subjective and even with morality.

In terms of being up to date, Arthur also provides illustrations of how Leibniz presages a whole range of scientific and mathematical developments including the work of Lagrange, Mach, Einstein and Feynman. In fact Arhur's *Leibniz* sets the scene for the current project so well that I am tempted to suggest that it should be obligatory preliminary reading! The key motivation for attempting an updating of Monadology is to explore just how much more there may be to learn from Leibniz's principles, which even now may not have been fully appreciated. The central suggestion is that Leibniz's monad is a very reasonable stab at identifying what we now know to be the indivisible dynamic units of our world – the modes of excitation described by modern field theory. Leibniz's application needs modification, but my suggestion is that if one

returns the basic principles that he uses to infer the nature of the monad the principles themselves still look very good and have the potential to form the basis of a fully contemporary account of how the dynamics of the world relate to our perceptions of it – which is the essential subject matter of science.

The format of the project, a re-writing of a masterwork, may be unconventional, but it was based on a desire to bring out not only the strengths of the original but also the potential strength of the global vision. The twenty-first century Monadology I have constructed is not intended as an end in itself so much as a way to reconsider all the implications of Leibniz's ideas in the context of current science and perhaps to identify where Leibniz is still ahead of the game.

Trying to crystallize Leibniz's rationale for choosing his world view into a few sentences is not easy, not so much because the view is complicated but more because it is so far removed from the intuitive view that a lot of re-setting of assumptions is needed before one can begin. Perhaps the starting point is that Leibniz sees that we have compelling evidence for there being at least one 'point of view' on the world. Where Descartes says that he can be sure that 'I am a thinking thing', Leibniz starts with fewer assumptions. What we can be sure of is that there is a point of view, or in Descartes's terms, perhaps 'an instance of thinking'. Leibniz assumes that there are no demons playing tricks and that our changing thoughts reflect perception of a real world, so this is a point of view on a world. So the first correction needed to the textbooks is that Leibniz is not an idealist in the sense of not believing in any real world. His analysis is more practical but also more subtle.

Leibniz is also not interested in solipsism. He accepts that there are many points of view on the world. Moreover, he accepts that these points of view must be based in real entities of some sort. Spinoza had suggested that such points of view would just be some of an infinite number of aspects or modes of the single entity that is Nature or the Universe. Leibniz was convinced that points of view had to be real entities, to explain each being distinct. Even if these entities are in some way just instances of relation back to the world they must be real instances rather than arbitrarily defined aspects. Much of Leibniz's philosophy arises from arguments about what real entities, or identities, must entail.

Leibniz might seem to have already saddled himself with some sort of 'substance dualism' or 'theory of two types of entity' with the world on the one hand and points of view on the other. A point of view does not immediately strike one as an element of physics. But Leibniz is aware of a long tradition in philosophy that challenges the idea that physics is about 'things' made of 'matter'. As James Ladyman has pointed out in his book *Every Thing Must Go* (2007) the intuitive concept of material things has no place in modern physics and probably never had a legitimate place in physics other than as a prop for relating it back to ordinary language and intuitive ways of categorizing experience. Leibniz may have had the advantage over us in that the recent idea that science has found 'material atoms' as some sort of tiny billiard balls or solar systems of billiard balls, which of course it never has, had not yet become popular mythology. Ideas about the constitution of the world were much more fluid in the seventeenth century. Leibniz need not commit himself to the nature either of a point of view or the world to be viewed in such terms.

His solution is to say that everything has to be seen in terms of *dynamic relation*. The nature of an entity is the way it relates dynamically to everything else. That seems to do well for a point of view – it is a relation of being informed by the rest of the world. It also works very well for the subject matter of physics, which is about the way entities relate dynamically to the world. Terms like mass and charge are shorthand for dispositions to interact with the world – to attract or repel or to resist change. Moreover, there is nothing particularly strange in describing the universal electromagnetic field 'from the point of view of an electron', indicating not so much a point of origin for co-ordinates as a domain of dynamic interaction.

Descartes had had difficulty seeing how the relations of the apparently indivisible entity of a thinking thing could be compatible with the mechanical relations of extended matter, which he regarded as an infinitely divisible aggregate of parts. For

him the two seemed irreconcilable. However, shortly after Descartes's death it became clear to physicists that the 'extension' of matter arose from internal forces. Understanding nature in terms of constituent forces presents quite different possibilities from having to understand it in terms of abutting parts – something that is still not fully appreciated today.

By 1690 Leibniz has convinced himself that the basic nature of an entity is what he calls 'force' but which is closer to what we now call 'energy'. That seems entirely in agreement with modern physics. Intuitively, we tend to think that energy must be underpinned by some 'stuff' aspect, often thought of in terms of 'mass'. (Note that this is almost certainly flavoured by recent schoolroom culture, since in 1640 Descartes had considered it is terms of 'extent'. Would a child say that there is 'more stuff' in a litre of water or in a, slightly heavier, gold ball, 5cm across? Stuff is a slippery concept.) However, for a physicist, mass has always been just another disposition to dynamic relation, and with the Higgs mechanism probably confirmed any sense that mass is 'the basic stuff' has evaporated.

Many people find it hard to think of entities entirely in terms of their relational power. There is a common complaint amongst philosophers that you cannot have relations without relata (things that relate). But Leibniz is not getting rid of relata. He is simply indicating that their only knowable nature is in their relation to the universe – in fact just as the equations of physics have it.

Leibniz was famously interested in the infinite and the infinitesimal. A point of view might seem to require an infinitesimal point in space to view from. However, Leibniz sees that this assumption is tied too much to our intuitive idea of mechanical interaction. A point of view is for him a metaphysical point in the sense that it is an indivisible relation to the world, but that need not require that it be situated in a 'physical point' in space. Another common error in interpreting Leibniz is to think that his monadic points of view do not even inhabit space and time. Leibniz is clear that they do, but not according to the rules of the phenomena that we intuitively think of as 'matter'.

The link between Leibniz's dynamic units, or monads, and the phenomena we recognize as matter is a subtle one but not based on some 'extra metaphysical reality'. We seem to perceive 'matter' rather than individual monads simply because our brains are designed mostly to pick out the behaviour of aggregates of monads. Leibniz recognizes that aggregates must obey quite different laws from those of single indivisible units. This may seem an odd idea but he was almost certainly right. Moreover, although many aggregates, like piles of stones, can be considered arbitrary, certain well-organized aggregates are for Leibniz, 'real bodies' in the sense that they are associated with a dominant indivisible dynamic unit or monad. This may appear even more obscure but I will indicate later how this is remarkably close to certain principles in very recent physics.

It may be important to re-emphasise that the 21st century Monadology given below is not intended to be an analysis of what Leibniz truly believed, as in an exercise in history of philosophy. Nor is it intended to be a precise prediction of what he would have believed were he still alive. Both questions are relevant to the project but the intention is to produce a personal account of how Leibniz's 1714 text might be used as a basis for a contemporary account of the principles of philosophy with the minimum of modification. As in the original document the intention is to be concise: to propose a framework for consideration rather than an exhaustive justification for each premise, with more detailed issues of interpretation dealt with in the subsequent commentary. Leibniz's original is itself provided with a large number of footnotes to a much more extended text, the *Theodicy*. It is a pity that *Theodicy* is one of Leibniz's most difficult and rambling works and reference to essays such as *Discourse on Metaphysics*, *New System* or *Specimen Dynamicum* might have been more helpful.

Where possible a direct translation of Leibniz's text (given on the right hand side in italics in French), is maintained in the new version (given on the left). In many cases this is unproblematic. In cases where the strength of Leibniz's point is less clear the text has still often been maintained if not apparently inconsistent with the final analysis, since experience suggests that Leibniz's insights are

not always apparent on first reading. In other cases as much of the original is retained as seems fitting but is qualified by additions, and, less often, deletions, which in a few cases involve major shifts in content.

New content, given in bold, has two main aims. The first is to indicate where Leibniz's insights seem compatible with specific aspects of modern physics. In many cases this confirms the validity of Leibniz's approach. The second is to address those issues where Leibniz's metaphysic no longer appears to be tenable. In these cases the new text makes significant changes. Many of these are an extension of the insight of AN Whitehead, informed by special relativity, regarding the need to cast the 'atoms of nature' as indivisible in time as well as space. Leibniz's monads are clearly spatially indivisible. However, their temporal relations do appear to be divisible, into a sequence of 'perceptions'. Exactly how this should be interpreted is by no means a simple matter and a section of the subsequent commentary is directed at trying to extract the most useful principles out of Leibniz's conception. Nevertheless, there is no doubt that in general terms Leibniz sees monads as enduring and passing through many 'states' like a 'living automatom' and this is in at least potential conflict with the concept of an indivisible dynamic relation to the world. The central implication of Whitehead's analysis is that a monadic dynamic unit must be seen not as an enduring entity but as a transient 'occasion of experience'. In this interpretation, the idea of a single immortal human soul has to be replaced by a multiplicity in time and space of 'soul-like' monadic units.

This shift in the way the monad is cast has further implications for the nature of causation. Leibniz couches this in terms of final (telic) and efficient causes. In my view recasting the monadic unit as an occasion provides a way of showing just how justified this distinction really was, although at the cost of suggesting that telicity comes in two rather different forms. This reinterpretation in turn suggests a way of recasting the moral aspects of Leibniz's philosophy more in keeping with the modern age but retaining a place for many of his original claims.

The synthesis proposed suggests that every element of Leibniz's original text contains powerful insights into the nature of both the physical world and the human condition. These remain as relevant now as when written and merit further exploration. I have no reason to think, or even hope, that the reader will want to accept the re-interpretation I have proposed in its entirety. It is intended more as a stimulus to debate about how Leibniz's principles may yet again prove useful in solving some very real problems in natural philosophy – of what is really going on in our world.

This brief introduction is followed by the text of the re-drafted Twenty-first Century Monadology itself. Further commentary relating to specific points arising in the re-drafting process is given after that. Many people have the experience that it takes time to become familiar with Leibniz's ways of thinking and if the text here is difficult to place in context it may be helpful to explore or re-explore some primary and secondary sources alongside it. I would strongly recommend the collection of Leibniz's main short philosophical works edited by Woolhouse and Francks (1998) as a primary source, in particular Discourse on Metaphysics, Specimen Dynamicum, Reflections on True Metaphysics and New System. Richard Arthur's *Leibniz* (2014) is an excellent overview of Leibniz''s approach and Daniel Garber's *Body, Substance, Monad* (2009) is also useful on the development of ideas.

Acknowledgement

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A 21st CENTURY MONADOLOGY

1. The monad, which is the subject of this text, is nothing but a simple substance, which may enter into composites. By 'simple' is meant 'without parts.' **A monad is a single dynamic mode, as described by physics, identifiable (in the language of physics) by parameters such as energy, mass, spin, charge and spatiotemporal domain.**[1]

2. And there must be simple substances, since there are composites; for a composite is nothing but a collection or aggregate of simple things.[2]

3. Now, in that which has no parts, there can be neither extension nor shape **in any sense that would allow divisibility**. And so monads are the real atoms of nature and, in a word, the elements of things.[3]

1. La Monade don't nous parlerons ici, n'est autre chose, qu'un substance simple, qui entre dans les composes; simple, c'est a dire, sans parties.

2. Et il faut qu'il y ait des substances simple puisqu'il y a des composes; car le composé n'est autre chose qu'un amas, ou aggregatum des simples.

3. Or la, ou il n'y a point de parties il n'y a ni étenduë, ni figure, ni divisibilité possible. Et ces monads sont les véritables Atomes de la Nature et en un mot les Elemens de choses.

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[1] The monad is now equated to an indivisible dynamic mode, as described by modern physics. Leibniz constantly modified his views in the light of scientific development so I trust he would approve. Dynamic modes are now defined by quantum field theory (QFT), but technical details are unimportant here. (See appendix for some further treatment.) These modes are often called 'particles' but are better thought of as dynamic patterns or 'units of action', examples being electron *orbitals*, phononic modes, or photonic modes (excitations of the EM field), with a certain content of energy and domains that are contingent on their environment. In general, modes relevant to familiar dynamics are transient, not enduring. This entails a significant change to Leibniz's model, yet Leibniz's premises are seen as retaining relevance right up to the end. As Leibniz implies, we should expect the modes of human monads to be of a very special type, with a high level of complexity in harmony with their biological milieu.

[2] Leibniz's original premise.

[3] Leibniz disallows 'extension' or 'shape' to monads for the reason that Descartes denies them for souls. He wants to avoid a dynamic divisibility that would entail more than one relation to the world. For Descartes, 'extension' involved exclusion of other things from a space, such that collections of small 'parts' would aggregate to form larger 'wholes' that would interact 'mechanically'. For Leibniz, this could only be an account of superficial appearance, requiring underpinning by a truly *dynamic* analysis. *Detectable* extension or shape for monads would imply parts because such extension or shape would be detected by the different ways each part interacts with light or mechanical force (each would have a different relation to the world). Although elsewhere Leibniz describes monads as 'pointlike', this is metaphysically, not spatially, pointlike. Both Descartes and Leibniz appear to envisage souls or monads as having non-infinitesmal spatiotemporal domains but not involving exclusion of other things from that domain, or *measurable* extent. Thus, the soul, for both philosophers, has some sort of dominance over part or all of the body without displacing the body from its extension. This seems strange. However, several modes in QFT, including those of light and sound, do just this; they do not exclude other modes from their domain. Even the domains of electrons, which do, are not measurable as shapes in the sense that different 'parts' of the electron can be found to interact differently. Descartes and Leibniz appear to be correctly identifying a counterintuitive aspect of fundamental dynamic elements here.

4. There is no way in which a simple substance **can undergo dissolution or be disassembled** by natural means.[4]

5. For the same reason there is no conceivable way in which a simple substance **can be assembled by** natural means, since it cannot be formed by the combination of parts.[5]

6. Thus it may be said that a monad can only come into being or come to an end all at once; that is, it can come into being only by creation and end by annihilation, while that which is compound comes into being or comes to an end by parts.[6]

7. Further, there is no way of explaining how a monad can be altered in quality or internally changed by any other created thing; since it is impossible to change the place of anything in it or to conceive in it any motion **between parts** of a sort which could be produced, directed, increased or diminished therein, although all this is possible in the case of compounds, in which there are changes among the parts. Monads have no windows, **in the sense that nothing can enter and 'add itself' to a monad, in the way that 'accidental properties', like speed of motion, did in the Scholastic view.** [7]

4. Il n'y a aussi point de dissolution a craindre, et il n'y a aucune maniere conceivable par laquelle une substance simple puisse perire naturellement.

5. Par la même raison il n y en a aucune, par laquelle une substance simple puisse commencer naturellement, puisqu'elle ne sçauroit être formé par composition.

6. Ainsi on peut dire que les monads ne sçauroient commencer, ni finir, que tout d'un coup, c'est a dire, elles ne sçauroient commencer que par creation et finir que par ahhihilation: au lieu, que ce qui est composé, commence ou finit par parties.

7. Il n'y a pas moïen aussi d'expliquer comment une monade puisse être alterée, ou changée dans son intérieur par quelque autre creature; puisqu'on n'y sçauroit rien transposer, ni concevoir en elle aucun mouvement interne qui puisse être excité, dirigé, augmenté ou diminué la-dedans; comme cela se peut dans les composes, ou il y a du changement entre les parties. Les monads n'ont point de fenêtres, par lequelle quelque chose y puisse entrer ou sortir. Les accidents ne sçauroient se detacher, ni se prmener hors des substances, comme faisoient autrefois les especes sensibles des scholastiques. Ainsi, ni substance, ni accident peut entrer de dehors dans une monade.

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[4] , See 6.

[5] , See 6.

[6] The main point of 4,5 and 6 appears to be that monads cannot be put together or taken apart. They are either there or not. That is consistent with modern physics. Leibniz may appear to be saying more: that monads are immortal and thus there is conservation of monad number. In modern physics energy is conserved but not individual modes. In fact Leibniz does indicate later that God can create, and perhaps annihilate, monads or souls at any time. It seems he wants human souls to be immortal but to have some flexibility to accommodate other phenomena plausibly.

[7] This premise is central to the monad concept, but has also led to most confusion. If a monad is to be defined by its dynamics, (as was clearly Leibniz's intention) it is simple because it has only one relation to the universe. It cannot have parts in the sense that some of it relates to the universe one way and some of it relates to the universe another way. In particular, a part of it cannot relate to another part of it in a way that the rest of it does not share. From this it follows that there is no mechanism whereby a monad could be internally rearranged, since there is no arrangement of parts within. Moreover, no 'extra part' can be added. He returns to his metaphor of the window (from Discourse on Metaphysics #26) to illustrate this. This reference to absence of windows is often misconstrued as meaning that monads are 'blind' but, as far as I can establish, this is quite wrong. Perception of the whole universe is the essence of the monad (see e.g. 14, 63). Windows are here meant as portals through which new ideas might be *added* to the monad (already a complete 'idea'), not routes of perception. Like Plato, Leibniz believed that all our ideas are already within us, we 'learn' nothing, merely 'reminisce'.

8. Yet the monads must have some qualities, otherwise they would not even be beings. And if simple substances did not differ in quality, there would be no means of detecting any change in things. For what is in the compound can come only from the simple elements it contains, and the Monads, if they had no qualities, would be indistinguishable from one another, since they do not differ in quantity. Consequently, space being a **dynamic** plenum, each part of space would always receive, in any motion, the equivalent of what it already had, and no one state of things would be discernible from another. **All would be symmetrical**.[8]

9. Indeed, each Monad must be different from every other, either in **spatiotemporal domain or other parameters.** For in nature there are never two beings that are perfectly alike and in which it is not possible to find an internal difference, or at least a difference founded upon an intrinsic quality. **In this regard, two major forms of monad are now recognised, obeying two distinct sets of laws, consistent with the intuitions of Descartes. Some monads (Fermi modes) have defined energy content with further multiples of energy content excluded from the mode. This exclusion, leads, indirectly, to both the aggregative aspect and the antitypy of matter, or, for Descartes, *res extensa*. Other monads (Bose modes) are modes with energy content of any number of whole multiples, which do not exclude each other from the mode. Most of these latter modes carry forces and are known to us as the basis of light, sound and spirit: for Descartes, *res cogitans*.**[9]

8. Cependant il faut que les monades aient quelques qualités, autrement ce ne seraient pas même des êtres. Et si les substances simples ne différaient point par leurs qualités, il n'y aurait pas de moyen de s'appercevoir d'aucun changement dans les choses, puisque ce qui est dans le composé ne peut venir que des ingrédients simples, et les monades étant sans qualités seraient indistinguables l'une de l'autre, puisqu'aussi bien elles ne diffèrent point en quantité: et par conséquent, le plein étant supposé, chaque lieu ne recevrait toujours, dans le mouvement, que l'équivalent de ce qu'il avait eu, et un état des choses serait indistinguable de l'autre.

9. Il faut même que chaque monade soit différente de chaque autre. Car il n'y a jamais dans la nature, deux êtres, qui soient parfaitement l'un comme l'autre, et où il ne soit possible de trouver une différence interne, ou fondée sur une dénomination intrinsèque.

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[8] Leibniz here introduces the other side of the monad concept: complexity. This might seem to pose a difficulty. However, Leibniz realizes that both indivisibility and complexity are required for basic units. Modern physics accommodates this very well. The dynamics of an electron orbital or a sound wave can be very complex, but the orbital or wave is indivisible. Dynamic has been added to plenum to indicate that space is not so much 'full of objects' as always the metric of some event or process – i.e. there is never 'nothing going on.'

[9] Leibniz differs from Descartes in making no categorical distinction between 'mental' and 'physical' substances. All substances obey the same principles. Nevertheless, he does recognize heterogeneity of monads. This makes his view both monistic and pluralist. Descartes's original distinction may prove to reflect a genuine duality of dynamic units, although his restriction of 'res cogitans' to single human souls now seems unwarranted. The modern explanation of antitypy is complex, but perhaps both Descartes and Leibniz show prescience here. Some non-excluding modes are 'travelling modes' like light (photonic) and some acoustic modes, or sound waves (phononic). Others (also phononic) are specifically associated with solid matter and seem best suited to the role of 'modes of spirit'.

The multiples of energy content allowed for Bose modes are not 'parts' of a mode but more like levels of strength of the mode. Within the mode they have no separate existence, since they entail no further relations. A change in level of strength does not alter the form of the mode. They could be likened to the steps in volume controlled by a TV handset.

The need for an intrinsic difference, or discernibility, between monads has been reviewed by Saunders (2003), who suggests a more subtle requirement for 'weak discernibility' based on relational features. Since in modern physics properties once regarded as intrinsic tend to be regarded as relational this shift seems relatively unproblematic.

10. **Since there is constant change in the universe** I also take as agreed that every created being, and consequently the created monad, is subject to change, and further that this change is continuous in each. **The form of a monad is always that of a progression in spacetime**.[10]

11. It follows from what has just been said, that the natural changes of the monads come from an internal principle, since an external cause can have no influence upon their inner being. **That is, no mechanical intermediary can 'steer' or 'rearrange' the monad**.[11]

12. But, besides the **general** principle of the change, **or progression**, there must be a particular pattern of changes that constitutes, so to speak, the specific nature and variety of each simple substance; **each mode has its unique dynamic parameters**.[12]

13. This particular pattern of changes should involve a multiplicity in the unit: in that which is simple. For, as every natural change takes place gradually, something changes and something remains unchanged; and consequently a simple substance must have internal relations varying in many ways, although it has no parts.[13]

10. Je prends aussi pour accordé, que tout être créé est sujet au changement, et par conséquent la Monade créée aussi, et même que ce changement est continuel dans chacune.

11. Il s'ensuit de ce que nous venons de dire, que les changemens naturels des monades viennent d'un principe interne, puisqu'une cause externe ne saurait influer dans son intérieur.

12. Mais il faut aussi, qu'outre le principe du changement il y ait un détail de ce qui change, qui fasse pour ainsi dire la spécification et la variété des substances simples.

13. Ce détail doit envelopper une multitude dans l'unité ou dans le simple. Car tout changement naturel se faisant par degrés, quelque chose change et quelque chose reste; et par conséquent il faut que dans la substance simple il y ait une pluralité d'affections et de rapports quoiqu'il n'y en ait point de parties.

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[10] See 12.

[11] See 12.

[12] Premise 10 may seem to conflict with premise 7. If a monad has no parts or internal arrangement, how can it change? This is clarified by premises 11 and 12. The change in the monad is a manifestation of an internal principle. Change is intrinsic to all monads. This fits with the dynamic description of modes in modern physics. The equations that describe modes indicate constant change, or progression with time. What may confuse is that what is observed is often independent of time because stages of progression cannot be distinguished by observation even though the progression between them is essential to the dynamic behaviour of the mode. A crude analogy is a spinning top, which is constantly changing yet always appears the same.

[13] The presence of relations within a monad in the absence of parts to relate may, again, seem contradictory. However, a complex d-subshell electron orbital seems to illustrate how this can be. Heil (2012) has indicated how one can resolve the problem by distinguishing substantial and spatial parts. A domain can have a left hand half and a right hand half without there having to be a substantial left hand 'part' and a right hand 'part'. A spinning top may occupy a domain with a left and right hand half but these are not left and right hand parts of the top. The top does indeed have parts that could be called that if still but the fundamental modes of modern physics do not have such parts at all. The ring of a bell is perhaps intermediate. It occurs on the right and on the left but there are no 'parts of a ringing'. The ringing may be supported by the existence of parts *of a bell* but that is not the same as parts of the *ringing of the bell*.

14. This passing condition, which involves and represents a multiplicity in the unit or in the simple substance, is nothing but what is called Perception, which is to be distinguished from Apperception or Consciousness, as will become clear. In this matter the Cartesian view is defective, for it treats as non-existent those perceptions of which we are not aware **in the consciousness we normally discuss**. This also led Cartesians to believe that human minds alone are monads, and that there are no 'souls' of animals nor other entelechies. **As explained later, this idea of perception can be most clearly understood for monads of massless force, or of spirit. Perception for monads carrying mass (generally Fermi modes), although it should play a similar role, may prove too confused or indeterminate for us to conceive.**[14]

15. The activity of the internal principle that produces manifest change such that **the monad progresses through its act of perception** may be called Appetition. It is true that the appetite will vary in the scope of perceptions to which it attains, **being limited by the way mode parameters relate to local field potentials**.[15]

14. L'état passager qui enveloppe et représente une multitude dans l'unité ou dans la substance simple n'est autre chose que ce qu'on appelle la Perception, qu'on doit distinguer de l'aperception ou de la conscience, comme il paraîtra dans la suite. Et c'est en quoi les Cartésiens ont fort manqué, ayant compté pour rien les perceptions dont on ne s'aperçoit pas. C'est aussi ce qui les a fait croire, que les seuls esprits étaient des monades, et qu'il n'y avait point d'ames des bêtes ou d'autres entéléchies, et qu'ils ont confondu avec le vulgaire un long étourdissement avec une mort à la rigueur, ce qui les a fait encore donner dans le préjugé scolastique des âmes entièrement séparées, et a même confirmé les esprits mal tournés dans l'opinion de la mortalité des âmes

15. L'action du principe interne, qui fait le changement ou le passage d'une perception à une autre, peut être appelé appétition; il est vrai, que l'appétit ne saurait toujours parvenir entièrement à toute la perception, où il tend, mais il en obtient toujours quelque chose, et parvient à des perceptions nouvelles.

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[14] It may not be immediately apparent why the internal progression of the monad should have anything to do with perception. However, if it is accepted that a monad is a purely dynamic unit and that all dynamics in physics are relational it becomes clear that the internal progression of the monad is a progression of a dynamic relation to the universe. That relation is, in other terms, the way in which the internal principle of the monad is expressed as a progression in harmony with the universe. In common parlance this might be called 'the way the environment influences the monad's progression'. That in turn can equally be considered as how the monad perceives the universe, since perception is mediated by influences of our environment on us.

[15] Leibniz's concept of appetition, which links serial perceptions for a single monad, is something that I am not sure can survive intact an interpretation in terms of the modes of modern physics. It raises the serious problem of temporal parts, which Leibniz never really explains. What may be worth retaining in the idea of appetition, over and above entelechy, is a sense of telicity. Modes are defined as much by their ends as by their beginnings in a way that involves relations between mode parameters and the field potentials in their domains. Field potentials are, in simple terms, levels of possibility for progression via paths in a spatiotemporal domain. These 'possible histories' form a single indivisible dynamic framework in which final outcome determines what is possible as much as the initial conditions. For this reason appetition may also be called 'anticipation' and may be seen as the playing out of something akin to a 'final cause' as conceived by Aristotle. Crucially, this is a feature of monads, *not* of aggregates, which have no appetition of their own. As discussed later, the 'final cause' aspect of modes cannot be equated directly with 'purpose'. Leibniz's original suggestion that appetition may not be entirely 'fulfilled' has been omitted, since for modes there is arguably no place for 'unfulfillment' since its existence is as much dependent on its final as its initial state. It always 'gets to where it is going'. This has complex implications for the final sections on ethics.

16. We have in ourselves experience of a multiplicity in a simple substance, when we find that the least thought of which we are conscious involves variety in its object. Thus all those who admit that the **human** 'soul' **or subject** is a simple substance should admit this multiplicity in the monad; and M. Bayle ought not to have found any difficulty in this.'[16]

17. Moreover, everyone must admit that perception and that which depends upon it are inexplicable on mechanical grounds, that is to say, by means of figures, motions or **any intermediary agents**. Imagine there were a machine, so constructed as to think, feel, and have perception, it might be conceived on an enlarged scale, while keeping the same proportions, so that one might go into it as into a mill. That being so, we should, on examining its interior, find only parts which work one upon another, and never anything by which to explain a perception. Thus it is in a simple substance, and not in a compound or machine, that perception must be sought for. Further, nothing but this (namely, perceptions and their changes) can be found in a simple substance. It is also in this alone that all the internal activities of simple substances can consist.[17]

16. Nous expérimentons en nous-mêmes une multitude dans la substance simple, lorsque nous trouvons que la moindre pensée dont nous nous appercevons, enveloppe une variété dans l'objet. Ainsi tous ceux, qui reconnaissent que l'âme est une substance simple, doivent reconnaître cette multitude dans la monade; et M. Bayle ne devait point y trouver de la difficulté, comme il a fait dans son Dictionnaire, article Rorarius

17. On est obligé d'ailleurs de confesser, que la Perception et ce, qui en dépend, est inexplicable par des raisons mécaniques, c'est-à-dire par les figures et par les mouvements [343]. Et feignant, qu'il y ait une machine, dont la structure fasse penser, sentir, avoir perception; on pourra la concevoir aggrandie en conservant les mêmes proportions, en sorte qu'on y puisse entrer comme dans un moulin. Et cela posé on ne trouvera en la visitant au dedans que des pièces qui poussent les unes les autres, et jamais de quoi expliquer une perception. Ainsi c'est dans la substance simple et non dans le composé, ou dans la machine, qu'il la faut chercher. Aussi n'y a-t-il que cela qu'on puisse trouver dans la substance simple, c'est-à-dire les perceptions et leurs changemens. C'est en cela seul aussi que peuvent consister toutes les Actions internes des substances simples.

[16] The dialogue between Leibniz and Bayle (Woolhouse and Francks, 1998) is illuminating. Bayle makes some pertinent comments but also appears to misinterpret Leibniz at times. Leibniz's responses assist understanding of his position, if only to a degree. Leibniz points out here that although a monad is simple in the sense of only having one relation to the universe, this relation is rich, or complex, as is evident from our percepts. His central point is that postulating parts would not help explain this richness, since then there would be multiple relations, not one rich relation. How any single dynamic relation can be rich is clearly a problem for Leibniz, and probably one he was not confident in solving. However, in modern physics the indivisible richness of fundamental, direct, dynamic relations is a central part of the theoretical framework, so Leibniz appears to have been right.

[17] Leibniz makes the crucial point that the relation of perception is *immediate* in the sense of having no mechanism or intermediary steps. There are no steps in a single relation to the universe. Perceptions cannot belong to 'systems' of units, themselves inter-connected by relations. Only basic units can perceive, through one such relation. There is a potential problem hidden here, in that our perception or knowledge of the world, which is not just of, but about, something, in an intentional sense, must involve indirect relations. For a percept to be about a distant object we need a collational system (a brain) that can make inferences from differences and those inferences will require multiple, and therefore, indirect, relations. That knowledge and rationality are more than simple perception Leibniz admits later. However, there is a suggestion that Leibniz oversimplifies the nature of perception, perhaps not surprisingly given what was known in his time. Nevertheless, this premise does seem to make a valid point that the content of (distinct) perception must be determined by some final immediate relation of the monad to its universe, even if that is a relation to signs that result from a complex computational analysis of distant events.

18. All simple substances or created monads might be called entelechies, **or anticipations,** for they have in them a certain perfection; they have a certain self-sufficiency which makes them the sources of their internal activities and, so to speak, incorporeal automata. **Thus, physics tacitly assumes that everything that might be called rationality, understanding, animacy or spirit stems ultimately (whether directly or indirectly) from the 'perfect' internal principles of monads, which are, each, in a sense, an Aristotelian final cause. Our conception of the 'interaction of traditional objects' is no more than an aggregate account of the operation of the internal principles of simples.**[18]

19. We might wish to give the name soul or psyche to everything that has perceptions and appetites in the general sense that I have explained, and then all simple substances or created monads **(at least modes of force)** might be so called. However, as both feeling and knowing are more than a bare perception, I think it right that the general name of monads or entelechies should suffice for simple substances which have perception only, and that a monad in which perception is more distinct, involving knowledge, subserved by memory, will here be given the name **listener. A listener can not only perceive the world but also know *about* the world, in the form of a 'story' of being something in that world.**[19]

[18] Leibniz is here pointing out that the awesome order of the physical world is not something lightly to be accounted for in terms of interactions between inert objects. He points out that everything derives from the internal 'entelechies' of monads, which are indeed awesome in their 'perfect' reliability. As Einstein said, the most amazing thing about the universe is that every tiny element 'knows what to do'. Moreover, as Feynman emphasized, at the elemental level this involves both huge mathematical complexity and a sort of 'anticipation' in which the existence of the mode is determined as much by its outcome as by its origin, almost as if it 'knows where it is going'.

[19] Leibniz clarifies the extent to which his approach is substance-monistic and that to which it is substance-pluralist, allowing also for some sort of 'spiritual' vs 'material' divide of the sort associated with Descartes.

18. On pourrait donner le nom d'Entéléchies à toutes les substances simples ou monades créées, car elles ont en elles une certaine perfection (ἔχουσι τό ἐντελές), il y a une suffisance (αὐτάρκειν) qui les rend sources de leurs actions internes et pour ainsi dire des Automates incorporels.

19. Si nous voulons appeler Ame tout ce qui a perceptions et appétits dans le sens général que je viens d'expliquer, toutes les substances simples ou monades créées pourraient être appelées ames; mais, comme le sentiment est quelque chose de plus qu'une simple perception, je consens, que le nom général de monades et d'entéléchies suffise aux substances simples, qui n'auront que cela; et qu'on appelle ames seulement celles dont la perception est plus distincte et accompagnée de mémoire.

However, he makes it clear that for him this is a distinction of degree or finesse rather than of principle. He is therefore suggesting what might be called a graded panexperientialism. In terms of reconciling perception with basic physics this has the advantage of being an essentially substance monistic view, but can capitalize on the heterogeneity of modes recognized in modern physics.

The new version presented here makes a major shift in emphasis at this point. The human monad with heightened perception based on memory and involving knowledge is not equated with an immortal soul but with an ephemeral 'listener' or perhaps 'member of an audience', for reasons that will become clear. Inasmuch as a persisting 'soul' is recognized in the new interpretation it is more like a 'living story' than any specific dynamic unit or event. The human listener monad is special in several respects, as suggested by Whitehead (for him an 'occasion'). It must have the internal complexity to apperceive or 'know' in a particularly distinct way and in terms of events in time and space. Moreover, it can only know these events if furnished with access to the output of a system, in our case a nervous system, that can infer the nature of distant events from complex comparisons across time and space.

20. For we sense that our bodies are sometimes in a condition in which nothing is remembered and we have no distinguishable perception; as when we fall into a swoon or when we are overcome with a profound dreamless sleep. In this state **there may be no monads within the body that achieve the status of listeners;** but as this state is not lasting, and heightened perception occurs again, a **listener** is something more than a bare monad. [20]

21. And it does not follow that in this state that there is a simple substance without any perception. That, indeed, cannot be, for the reasons already given; for **substances** cannot continue to exist without being affected in some way, and this affection is nothing but its perception. **But when monads within us are only presented with confused signs**, in which there is nothing distinct, one is stunned; as when one turns continuously round in the same way several times in succession, whence comes a giddiness which may make us swoon, and which keeps us from distinguishing anything. **Indeed, it now appears unlikely that there are souls with a continual existence; rather apperceiving monads may come in to existence and disappear quite regularly. Monads of matter (Fermi modes) may or may not endure for long periods but monads of force are generally transient. Those associated with our consciousness probably last a fraction of a second, as in Whitehead's concepts of an 'occasion', being constantly created and annihilated during thought.**[21]

20. Car nous expérimentons en nous-mêmes un état, où nous ne nous souvenons de rien et n'avons aucune perception distinguée, comme lorsque nous tombons en défaillance ou quand nous sommes accablés d'un profond sommeil sans aucun songe. Dans cet état l'âme ne diffère point sensiblement d'une simple monade, mais, comme cet état n'est point durable, et qu'elle s'en tire, elle est quelque chose de plus.

21. Et il ne s'ensuit point, qu'alors la substance simple soit sans aucune perception. Cela ne se peut pas même par les raisons susdites; car elle ne saurait périr, elle ne saurait aussi subsister sans quelque affection, qui n'est autre chose, que sa perception: mais quand il y a une grande multitude de petites perceptions, où il n'y a rien de distingué, on est étourdi; comme quand on tourne continuellement d'un même sens plusieurs fois de suite, où il vient un vertige qui peut nous faire évanouir et qui ne nous laisse rien distinguer. Et la mort peut donner cet état pour un tems aux animaux.

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[20] Here Leibniz makes use of his assumption that a monad is an enduring unit. Whitehead argues against this, replacing the monad with an evanescent 'occasion'. Later premises will be modified in the light of Whitehead's view but it is not entirely clear that Leibniz's view should be completely abandoned. It remains possible that monadic modes in biological systems could last at least for the lifetime of individual cells.

[21] New material draws on Whitehead's reassessment of the concept of existence in a framework of spacetime rather than one in which space and time are considered on different terms. A simple indivisible dynamic 'atom of nature' cannot have different interactions 'of the past' and 'of the present' any more than it can of 'this part' or 'that part'. The domain of the monad must be brief as well as localized. This entails dissociation of the concept of a soul in the sense of the dynamic essence of a life, from any individual material unit. The traditional 'soul' becomes, if anything, a 'real living story': a dynamic pattern defined in terms of a 'narrator'. In some ways this reinforces the dynamic approach that Leibniz favoured. It also emphasizes the relational nature of the universe in a way that may accord with Donne's 'Ask not for whom the bell tolls – it tolls for thee.' ; stories only exist where there are also hearers. This shift in emphasis is radical but may allow a more modern reading of the relation between physical dynamics and ethics that indicates the depth of insight behind Leibniz's superficially strange claim that we live in a perfect world.

The nature of the modes that are 'monads of matter' is hard to define and may be indeterminable. Modes in nuclei and inner electron orbitals may be very stable but valency electron modes may be as evanescent as the modes of force that interact with them. It may be that every time the parameters of a mode are determined by interaction the mode ceases. This may seem metaphysically unsatisfactory but the idea of things being real but indeterminable is well established. Fortunately, it seems unlikely that this poses crucial difficulties for understanding the human listener.

22. In the natural course of events, every present instance of perception is the consequence of a preceding instance; and similarly a present instance is pregnant with the future. **Since a monad can have neither spatial nor *temporal* parts it cannot have a past, present and future, but only a present, which must be its life span. Thus, the perception of one monad, or occasion, is followed by that of another. Although many modes of force are brief, lasting modes of force exist as the forces of form of aggregates such as 'objects' or living cells. These we know as elastic or acoustic forces. It is possible that some such modes last for the lifetime of a living cell or body but the rapid sequence of our apperceptions indicates that the modes of our consciousness are very brief and almost certainly less than a second in duration: no longer than a 'present moment' appears to last. They are the 'occasions' of Whitehead. The conception of 'enduring substance' is now set aside, such that the monad is a truly dynamic entity.** [22]

22. Et comme tout présent état d'une substance simple est naturellement une suite de son état précédent, tellement, que le présent y est gros d'avenir.

23. When you wake out of a period of unconsciousness, you have well-formed conscious perceptions. Consequently, **monads within the body must have been perceiving before**, since, in the natural course of events, a perception can only arise from previous perceptions — just as, in the natural course of events, a motion can only arise from a previous motion.[23]

23. Donc puisque réveillé de l'étourdissement, on s'apperçoit de ses perceptions, il faut bien, qu'on en ait eu immédiatement auparavant, quoiqu'on ne s'en soit point apperçu; car une perception ne saurait venir naturellement, que d'une autre perception, comme un mouvement ne peut venir naturellement que d'un mouvement.

[22] Leibniz considered the atoms of nature to be enduring substances that had a succession of such instances or states of perception. However, AN Whitehead came to understand that the indivisibility principle that Leibniz so powerfully applied the spatial aspects of dynamics must also be applied to the temporal. Thus the monad, which is indivisible in space but enduring in time, with a past, present and future, must be replaced by an 'occasion' that is indivisible in spacetime. This development is in a sense taking Leibniz's own dynamism to its logical conclusion.

[23] This reworking of premise 23 removes the potentially troublesome suggestion that there needs to be some form of higher order consciousness of our percepts beyond the special case of introspection. It shifts the sequence to multiple modes. Although this appears to be in conflict with Leibniz's view here, later premises appear to make the conflict less marked.

24. **And if our perceptions were not part of a highly organized sequence, involving what we call memory, which allows us to cast the universe in terms of ideas of distant times and places** we should always be in a state of stupor. And this is the state in which the bare monads are**.**[24]

25. We see also that nature has given heightened perceptions to monads within animals, from the care she has taken to provide them with organs, which collect numerous rays of light, or numerous undulations of the air, in order, by uniting them, to make them have greater effect. Something similar to this takes place in smell, in taste and in touch, **and in the many other sense modalities mediated by other organs of the body**. That which takes place **in listeners** represents what **is constructed** in those bodily organs. **Our meaningful or heightened perceptions are thus dependent on a sequence of perceptions of other monads within the body that Whitehead has termed a nexus. It is this complex nexus that allows a listener to have knowledge rather than just experience. Moreover, the complex nexus includes not one listener at any one time, but many, forming an 'audience'. Thus the heightened perception that is familiar to us belongs to one of many listeners within our body. The nexus is therefore somewhat like a theatre company presenting a living story to an audience, the story being the precious essence of what we call the 'person'.**[25]

24. L'on voit par là, que si nous n'avions rien de distingué et pour ainsi dire de relevé, et d'un plus haut goût dans nos perceptions, nous serions toujours dans l'étourdissement. Et c'est l'état des monades toutes nues.

25. Aussi voyons-nous que la nature a donné des perceptions relevées aux animaux par les soins qu'elle a pris de leur fournir des organes, qui ramassent plusieurs rayons de lumière ou plusieurs ondulations de l'air pour les faire avoir plus d'efficace par leur union. Il y a quelque chose d'approchant dans l'odeur, dans le goût et dans l'attouchement et peut-être dans quantité d'autres sens, qui nous sont inconnus. Et j'expliquerai tantôt, comment ce qui se passe dans l'âme représente ce qui se fait dans les organes.

[24] Leibniz implies in his original that our perceptions rise above those of bare monads because they are heightened or 'spicier'. This raises the difficulty that we have no reason to have any idea how 'spicy' the perceptions of bare monads might be. What we can be fairly sure of is that they will not be organized to form the sort of narrative about past and future that we have, which we can reasonably assume requires the availability of a system that can store and retrieve material in the way that a brain or Turing machine can.

[25] Leibniz's original with a little updating relating to the mutiple sense pathways now understood to involve a wide range of organs, including internal kinaesthetic and chemical receptors, and some explanatory material. Leibniz recognizes here that heightened perception depends on data received by these organs being integrated ('united') and collated before being made available to the soul or listener. This is crucial to the mechanism of knowledge. Leibniz says less about the specifics of this than Descartes, which may give the false impression that the 'soul' monad is some rather magical entity smeared out over the whole body that is 'dominates'. However, Leibniz indicates elsewhere that if we are interested in the detail of biological processes we have to stick to the ordinary language of physics. He is not intending to deny that specific local physiological processes in brains will be involved in the run up to the relation of perception ot the soul monad. It is just that the relation of perception itself cannot be decomposed into further 'mechanical' processes. There does seem to be something of a gap in Leibniz's account here, however, and perhaps for reasons explored later. As it stands his account is much easier to interpret for unicellular organisms, which behave more like simple dynamic units.

26. Memory provides a living story with a kind of consecutiveness, which resembles reason, but which is to be distinguished from it. Thus we see that when the **listeners** of animals have a perception of something which strikes them and of which they have formerly had a similar perception, they are led, by means of representations in memory, to expect what was combined with the thing in this previous perception, and they come to have feelings similar to those they had on the former occasion. For instance, when a stick is shown to dogs, they remember the pain it has caused them, and howl and run away.[26]

27. And the strength of the mental image that impresses and moves these souls comes either from the magnitude or the number of the preceding perceptions. For often a strong impression produces all at once the same effect as a long-formed habit, or as many and oft-repeated ordinary perceptions.[27]

28. In so far as the concatenation of their perceptions is due to the principle of memory alone, men act like the lower animals, resembling the empirical physicians, whose methods are those of mere practice without theory. Indeed, in three-fourths of our actions we are nothing but empirics. For instance, when we expect that there will be daylight to-morrow, we do so empirically, because it has always so happened until now. It is only the astronomer who thinks it on rational grounds.[28]

29. But it is the **partial** knowledge of necessary and eternal truths that distinguishes us from the mere animals and gives us Reason and the sciences, raising us to a degree of knowledge of ourselves and of the Universe. And it is this in us that is called the rational mind.[29]

26. La mémoire fournit une espèce de consécution aux âmes, qui imite la raison, mais qui en doit être distinguée. C'est que nous voyons que les animaux ayant la perception de quelque chose qui les frappe et dont ils ont eu perception semblable auparavant, s'attendent par la représentation de leur mémoire à ce qui y a été joint dans cette perception précédente et sont portés à des sentiments semblables à ceux qu'ils avaient pris alors. Par exemple: quand on montre le bâton aux chiens, ils se souviennent de la douleur qu'il leur a causée et crient et fuient.

27. Et l'imagination forte, qui les frappe et émeut, vient ou de la grandeur ou de la multitude des perceptions précédentes. Car souvent une impression forte fait tout d'un coup l'effet d'une longue habitude, ou de beaucoup de perceptions médiocres réitérées.

28. Les hommes agissent comme les bêtes en tant que les consécutions de leurs perceptions ne se font que par le principe de la mémoire; ressemblant aux Médecins empiriques, qui ont une simple practique sans théorie; et nous ne sommes qu'empiriques dans les trois quarts de nos actions. Par exemple, quand on s'attend qu'il y aura jour demain, on agit en empirique par ce que cela s'est toujours fait ainsi jusqu'ici. Il n'y a que l'Astronome qui le juge par raison.

29. Mais la connaissance des vérités nécessaires et éternelles est ce qui nous distingue des simples animaux et nous fait avoir la raison et les sciences, en nous élevant à la connaissance de nous-mêmes et de Dieu. Et c'est ce qu'on appelle en nous Ame raisonnable ou esprit.

[26] Leibniz's original (with listeners added).
[27] Leibniz's original.
[28] Leibniz's original.
[29] Leibniz's original with knowledge qualified by partial.

'Dieu' (God) is replaced by 'Universe' at this point, as seems adequate, although an alternative solution will be developed later.

30. It is also through the knowledge of necessary truths, and through their abstract expression, that we rise to acts of reflection, which make us think of what is called I, and observe that this or that is within us: and thus, thinking of ourselves, we think of concepts of being, of substance, of the simple and the compound, of the immaterial, and of the immortal, conceiving that what is constrained in us is in itself without constraint. And these acts of reflection furnish the chief objects of our reasonings. **Our conceptions may still often be flawed but, with the use of reason, over history flaws are gradually identified and corrected.** [30]

30. C'est aussi par la connaissance des vérités nécessaires et par leurs abstractions, que nous sommes élevés aux actes réflexifs, qui nous font penser à ce qui s'appelle Moi, et à considérer que ceci ou cela est en nous: et c'est ainsi, qu'en pensant à nous, nous pensons à l'Être, à la substance, au simple et au composé, à l'immatériel et à Dieu même, en concevant que ce qui est borné en nous, est en lui sans bornes. Et ces actes réflexifs fournissent les objets principaux de nos raisonnements.

31. Our reasonings are grounded upon two great principles: firstly that of contradiction, or impossibility, in virtue of which we judge false that which involves a contradiction, and true that which is opposed or contradictory to the false.[31]

31. Nos raisonnements sont fondés sur deux grands principes, celui de la Contradiction, en vertu duquel nous jugeons faux ce qui en enveloppe, et vrai ce qui est opposé ou contradictoire au faux.

32. And secondly, that of sufficient reason, in virtue of which we hold that there can be no fact real or existing, no statement true, unless there be a sufficient reason, why it should be so and not otherwise, although these reasons usually cannot be known by us.[32]

32. Et celui de la Raison suffisante, en vertu duquel nous considérons qu'aucun fait ne saurait se trouver vrai ou existant, aucune énontiation véritable, sans qu'il y ait une raison suffisante pourquoi il en soit ainsi et non pas autrement, quoique ces raisons le plus souvent ne puissent point nous être connues.

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[30] Leibniz's original with a caveat that our reflections, including those on what is called 'I' may still be confused in important respects.

[31] The next few paragraphs give the basics of Leibniz's views on reasoning and logic, most of which remains acceptable, although subject to debate. Leibniz's principle of contradiction may appear perverse, especially with truth described as contradiction of contradiction. However, the principle may serve to highlight the central importance of *difference* in the way the brain analyses sensory inputs. In the absence of a better definition of truth Leibniz's original has been retained, as it may contain insights beyond what is immediately apparent.

[32] This may be Leibniz's (original) way of giving a positive basis for truth, but with the rider that we often have no understanding of what makes a truth true.

33. There are also two kinds of truths, those of reasoning and those of fact. Truths of reasoning are necessary and their opposite is impossible: truths of fact are contingent and their opposite is possible. When a truth is necessary, its reason can be found by analysis, resolving it into more simple ideas and truths, until we come to those that are primary.[33]

34. It is thus that in Mathematics speculative Theorems and practical Canons are reduced by analysis to Definitions, Axioms and Postulates.[34]

35. In short, there are simple ideas, of which no definition can be given; there are also axioms, postulates, or primary principles, which cannot be proved, and indeed have no need of proof; and these are propositions of identity, whose opposite involves an express contradiction.[35]

36. But there must also be a sufficient reason for contingent truths or truths of fact, that is to say, for the sequence or connection of the things which are dispersed throughout the Universe of created beings, in which the analyzing into particular reasons might go on into endless detail, if we were to consider these in terms of the mechanics of infinitely divisible bodies. There **is a combinatorial complexity of past** forms and motions that go to make up the efficient cause of my present writing; and there is a similar complexity of minute tendencies and dispositions of **my listeners**, which go to make its **apparent** final cause.[36]

33. Il y a aussi deux sortes de vérités, celles de raisonnement et celles de fait. Les vérités de raisonnement sont nécessaires et leur opposé est impossible, et celles de fait sont contingentes et leur opposé est possible. Quand une vérité est nécessaire, on en peut trouver la raison par l'analyse, la résolvant en idées et en vérités plus simples, jusqu'à ce qu'on vienne aux primitives.

34. C'est ainsi que chez les Mathématiciens les Théorèmes de spéculation et les Canons de practique sont réduits par l'analyse aux Définitions, Axiomes et Demandes.

35. Et il y a enfin des idées simples, dont on ne saurait donner la définition; il y a aussi des axiomes et demandes ou en un mot des principes primitifs, qui ne sauraient être prouvés et n'en ont point besoin aussi; et ce sont les énontiations identiques, dont l'opposé contient une contradiction expresse.

36. Mais la raison suffisante se doit aussi trouver dans les vérités contingentes ou de fait, c'est-à-dire dans la suite des choses répandues par l'univers des créatures, où la résolution en raisons particulières pourrait aller à un détail sans bornes à cause de la variété immense des choses de la Nature et de la division des corps à l'infini. Il y a une infinité de figures et de mouvements présents et passés, qui entrent dans la cause efficiente de mon écriture présente; et il y a une infinité de petites inclinations et dispositions de mon âme présentes et passées, qui entrent dans la cause finale.

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[33] Leibniz's distinction here has been subject to a complex debate. This is not central to the metaphysical framework and so the original is retained.

[34] Leibniz's original.

[35] Leibniz's original.

[36] Leibniz emphasizes the complexity of causation. He saw this as infinite. Modern physics may suggest a finite quantum level 'grain' but confirms the combinatorial complexity of causation. Leibniz touches on further complexity by mentioning both Aristotle's concepts of efficient and final cause. Modern physics suggests that Aristotelian causal categories could be redefined, in a way that may fit quite well with Leibniz's insights. Efficient causes may be seen as the mechanical causes of traditional Newtonian physics. Final cause may then correspond to the 'anticipatory' form of causation found in the fundamental, or immediate relations of individual (monadic) modes. This creates a tension in our description of causation that may have implications for ethics, as indicated later. A distinction probably also has to be made between final causes at monadic and universal levels. With involvement of multiple listeners there is also an uneasy relation to the intuitive idea of 'personal purpose'. For this reason 'final cause' is qualified here by 'apparent'.

37. And as all this detail again involves other prior or more detailed contingent things, each of which still needs a similar analysis to yield its reason, we are no further forward: and the sufficient or final reason must be outside of the sequence or series of particular contingent things, however complex this series may be. **Final causes involve indivisible dynamic relations between monad and Universe, not a series of efficient causes based on the components of an aggregate with which a monad may be associated. This distinction is, in general, only confusedly understood by man. Our difficulty in this respect may be perhaps because the knowledge of our listeners depends on relations of aggregates within our sensory pathways. It may be that we can only know in terms of aggregates.**[37]

38. Thus if there is a final reason of things, it must be in a necessary entity, in which the variety of particular changes exists only eminently, as in its source; and this entity we may call the Necessary Being. **Final causes associated with monads are, therefore, manifestations of a global final cause, necessity or sufficient reason. Thus the monad and the totality of the Universe both manifest an aspect of telicity, in contrast to aggregates of matter, which do not.**[38]

37. Et comme tout ce détail n'enveloppe que d'autres contingents antérieurs ou plus détaillés, dont chacun a encore besoin d'une Analyse semblable pour en rendre raison, on n'en est pas plus avancé, et il faut que la raison suffisante ou dernière soit hors de la suite ou séries de ce détail des contingences, quelqu'infini qu'il pourrait être.

38. Et c'est ainsi que la dernière raison des choses doit être dans une substance nécessaire, dans laquelle le détail des changemens ne soit qu'éminemment, comme dans la source, et c'est ce que nous appelons Dieu.

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[37] In Leibniz's original, he seems to be indicating that our knowledge of causation, effectively our knowledge of the world, can only tend towards an understanding because of its combinatorial complexity. An addendum is given that tries to explain this further in terms of the distinction between types of cause. This is discussed in more detail in the appendix. Leibniz also indicates that the final causes of monads can ultimately only be explained from 'outside' as facets of operation of the laws of the universe.

[38] Leibniz's original, with 'Necessary Being' substituted for 'God'. Leibniz seems to be arguing, reasonably, that although the events going on around us form a causal network of combinatorial complexity they must yet be anchored in some common source of regularity or reason. Modes do not just go off on their own doing what they please. In a sense the vast array of individual events must merely be manifestations of some 'grand schema' that we can call the Universe. This is consistent with the view in modern physics that all modes are, in a sense, asymmetries of the universe progressing according to regularities of the whole, rather than whims of individual modes. And just as for the individual mode, the ultimate fate of the universe appears to be pre-determined by some unknown source of 'sufficient reason'. On the other hand, Leibniz does not reduce monads to mere modes or facets of a sinlge continuous whole in the way that Spinoza did. Leibniz saw them as true individual substances. Whether this is relevant to modern physics is unclear but it is of note that while the dynamic laws of physics appear to be continuous, their instantiation does appear to be by discrete (and 'actual' in Whitehead's terms) individual dynamic units ('quanta').
Leibniz's requirement of a source of causation, in terms of a 'Necessary Being' or God may seem at odds with physics. However, taken that Leibniz would agree with modern physics that no further *material* substance is required, it is arguable that physics has to postulate some sort of prior overarching 'necessity' to make sense of regular dynamics at all. It simply denies that such a necessity can be delineated or explained in any further way, which might be very close to Leibniz's position.

39. Now as this entity is a sufficient reason of all this variety of particulars, which are also connected together throughout, there is only one Necessary Being, and this Necessary Being must be considered sufficient.[39]

40. We may also hold that this supreme entity, which is unique, universal and necessary, nothing outside of it being independent of it, and which is a pure sequence of possible being, must not be constrained by anything and must contain as much reality as is possible.[40]

41. Whence it follows that the Necessary Being is perfect, if perfection is nothing but the abundance of positive reality, in the strict sense, leaving out of account the **asymmetries** or bounds in things which are limited. And where there are no bounds, that is to say, in the Necessary Being, perfection is absolutely unconstrained.[41]

39. Or cette substance étant une raison suffisante de tout ce détail, lequel aussi est lié par tout, il n'y a qu'un Dieu, et ce Dieu suffit.

40. On peut juger aussi que cette substance suprême qui est unique, universelle et nécessaire, n'ayant rien hors d'elle qui en soit indépendent, et étant une suite simple de l'être possible, doit être incapable de limites et contenir tout autant de réalité qu'il est possible.

41. D'où il s'ensuit, que Dieu est absolument parfait, la perfection n'étant autre chose, que la grandeur de la réalité positive prise précisément, en mettant à part les limites ou bornes dans les choses qui en ont. Et là, où il n'y a point de bornes, c'est-à-dire en Dieu, la perfection est absolument infinie.

[39] Leibniz's original with his alternative title of 'Necessary Being' (see 45) used in preference to God to avoid anthropomorphic implications. 'Necessary Existent' might be preferable but is clumsy. "Being' is taken simply to imply existing, although it is clear that this existence entails some form of 'reason' or 'power' or telicity.

[40] This is in keeping with motivation in modern physics to minimize the need for arbitrary or restricted parameters in the universe. There is a constant search for a framework, such as supersymmetry, that minimises apparently arbitrary parameters (e.g. mass and charge of particles). Where arbitrary parameters, such as the cosmological constant, do seem to remain some suggest that we should consider our environment as one of a set of universes, a Multiverse, in which all possible values of the parameter are expressed somewhere at some time. An alternative, perhaps closer to Leibniz is that 'reality' in modern physics may in a sense entail knowledge and only certain values for parameters could give rise to our level of knowledge. This is a form of the anthropic principle.

[41] Leibniz gives a more detailed account of perfection in 58, being the greatest possible combination of variety and order or symmetry. This contrasts with the individual monad, which being 'just one point of view' necessarily lacks variety, and also concommitent symmetry. It is consistent with the identification of individual modes with asymmetries in modern field theory. This premise has been ridiculed in moral terms, but in mathematical terms Leibniz's argument seems durable.

42. It follows also that created beings derive their perfections, **certainties or symmetries, from the Necessary Being,** but that their imperfections, uncertainties or asymmetries, reflect their own nature, which is incapable of being unconstrained **(being constrained by the laws of possible relation to the Universe).** For it is in this that they differ from the Necessary Being. An instance of this original imperfection of created beings may be seen in the natural inertia of bodies.[42]

43. It is also true that in the Necessary Being there is not only the source of existences but also that of essences, of ways of being, in so far as they are real, that is to say, the source of what is real in the possible. For the understanding of the Necessary Being is the region of eternal truths or of the ideas on which they depend, and without it there would be nothing real in the possibilities of things, and not only would there be nothing in existence, but nothing would even be possible. **Thus reality is inseparable from knowledge and understanding and thus what is possible must entail their possibility.**[43]

42. Il s'ensuit aussi que les créatures ont leurs perfections de l'influence de Dieu, mais qu'elles ont leurs imperfections de leur nature propre, incapable d'être sans bornes. Car c'est en cela qu'elles sont distinguées de Dieu. Cette imperfection originale des créatures se remarque dans l'inertie naturelle des corps.

43. Il est vrai aussi, qu'en Dieu est non seulement la source des existences mais encore celle des essences, en tant que réelles, ou de ce qu'il y a de réel dans la possibilité. C'est parce que l'entendement de Dieu est la région des vérités éternelles, ou des idées dont elles dépendent, et que sans lui il n'y aurait rien de réel dans les possibilités, et non seulement rien d'existant, mais encore rien de possible.

[42] The distinction that Leibniz makes here between the 'imperfect' modes and the unconstrained perfection of the universe echoes well with modern physics in terms of the concept of asymmetry. Moreover, whereas the regularities that underlie modes are constant and involve continuous variables, instances of modes themselves, coming as they do in discontinuous units, cannot be described entirely in terms of the constant regularities. They are significantly unpredictable. It is intriguing that Leibniz considers inertia an 'imperfection'. This may be a heuristic red herring but it is intriguing that inertia is now looking to be related to the way modes interact with what would otherwise be a symmetrical uniform Higgs field, generating asymmetries not only in the Higgs field but in spacetime itself. (Note that inertia was about the only physical property other than shape and motion that was well recognized in Leibniz's time. Perhaps he could have made a similar comment about charge.)

[43] Leibniz's original, with an added comment on the entailment of understanding within reality. He appears to point out that what were introduced as the internal principles of modes are in a deeper sense the possibilities available to the Universe and in that sense are instances of operation of regularities of the Universe rather than independent forces. This is consistent with the modern view of modes as the possible patterns of perturbations of universal fields.

44. For if there is a reality in essences or possibilities, or rather in eternal truths, this reality must needs be founded in something existing and actual, and consequently in the existence of the necessary Universe, in which essence involves existence, or in which to be possible is to be actual.[44]

45. Thus the Necessary Being alone has this prerogative that it must necessarily exist, if it is possible. And as nothing can interfere with the possibility of that which involves no constraints, no negation and consequently no contradiction, this is sufficient of itself to make known the existence of the Necessary Being a priori. We have thus proved it, through the reality of eternal truths. But a while ago we proved it also a posteriori, since there exist contingent beings, which can have their final or sufficient reason only in the necessary existing thing, which has the reason of its existence in itself.[45]

46. We must not, however, imagine, as some do, that eternal truths, being dependent on the Necessary Being, are arbitrary and depend on divine will, as Descartes appears to have held. Necessary truths depend solely on the Universal laws of understanding and are their inner object.[46]

44. Cependant il faut bien que s'il y a une réalité dans les Essences ou possibilités, ou bien dans les vérités éternelles, cette réalité soit fondée en quelque chose d'existant et d'actuel, et par conséquent dans l'existence de l'Être nécessaire, dans lequel l'essence renferme l'existence, ou dans lequel il suffit d'être possible pour être actuel .

45. Ainsi Dieu seul (ou l'Être nécessaire) a ce privilège, qu'il faut qu'il existe, s'il est possible. Et comme rien ne peut empêcher la possibilité de ce qui n'enferme aucunes bornes, aucune négation et par conséquence aucune contradiction, cela seul suffit pour connaître l'Existence de Dieu a priori. Nous l'avons prouvée aussi par la réalité des vérités éternelles. Mais nous venons de la prouver aussi a posteriori puisque des êtres contingents existent, lesquels ne sauraient avoir leur raison dernière ou suffisante que dans l'Être nécessaire, qui a la raison de son existence en lui-même.

46. Cependant il ne faut point s'imaginer avec quelques-uns, que les vérités éternelles étant dépendantes de Dieu, sont arbitraires et dépendent de sa volonté, comme Des Cartes paraît l'avoir pris et puis M. Poiret. Cela n'est véritable que des vérités contingentes dont le principe est la convenance ou le choix du meilleur, au lieu que les vérités nécessaires dépendent uniquement de son entendement et en sont l'objet interne.

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[44] Leibniz's original.

[45] Leibniz's original. The arguments are contentious, but arguably nobody has generated anything better.

[46] Leibniz here appears again to deny an arbitrariness of the essential regularities of the universe. It seems that Leibniz is wanting to indicate that his conception of a God is not of some intervening agent but of a consistently rational necessity – distancing himself from Descartes and Malebranche. Effectively, Leibniz is denying 'divine whim'. In the original premise Leibniz talks of choice being available when it comes to contingent truths (now omitted). He talks of a 'choice of the best'. Choice is a difficult concept to marry with the modern view of causal dynamics. This view allows for uncertainty but does not give any indication of what a 'choice' might be. (Despite the fact that 'choice' is often referred to in interpretation of quantum theory, as in 'delayed choice experiments'.) It may be that Leibniz's sense of 'choice of the best' can be retained as something like an expression of the principle of least action, or as in light always 'choosing' to take the shortest path between two points.

47. Thus the Necessary Being alone is the primary unity or original entity, of which all created or derivative monads are products and have their birth, so to speak, **through continual generation of asymmetries of the Universe from moment to moment,** and are limited by the receptivity of that which is created, which is essentially bounded.[47]

48. In the Necessary Being there is Power, which is the source of all. There is also Knowledge, whose content is the variety of the ideas, and finally Will, which makes changes or products according to the principle of the best. These characteristics correspond to what in the created monads forms the ground or basis, to the faculty of Perception and to the faculty of Appetition. But in the Necessary Being these characteristics are not limited to **one point of view**, as in the monad[48].

47. Ainsi Dieu seul est l'unité primitive ou la substance simple originaire, dont toutes les Monades créées ou dérivatives sont des productions, et naissent, pour ainsi dire, par des fulgurations continuelles de la Divinité de moment en moment, bornées par la réceptivité de la créature à laquelle il est essentiel d'être limitée.

48. Il y a en Dieu la Puissance, qui est la source de tout, puis la Connaissance, qui contient le détail des Idées, et enfin la Volonté, qui fait les changements ou productions selon le principe du meilleur. Et c'est ce qui répond à ce qui dans les Monades créées fait le sujet ou la base, la faculté perceptive et la faculté appétitive. Mais en Dieu ces attributs sont absolument infinis ou parfaits, et dans les Monades créées ou dans les Entéléchies (ou perfectihabies, comme Hermolaüs Barbarus traduisait ce mot) ce n'en sont que des imitations à mesure qu'il y a de la perfection.

[47] Leibniz here, somewhat surprisingly, seems to suggest that monads can be born at any time through 'continual flashes of divinity, so to speak'. (This has been replaced by an account in terms of novel asymmetries, more consistent with field theory!) This is in apparent conflict with the claim, in the *Principles of Nature and Grace Based on Reason*, that monads are immortal. It may be that Leibniz is using 'monad' in a broader scope in Monadology, to include those that are not at the level of 'souls'. Other aspects of Monadology indicate that Leibniz is still committed to immortality for the human soul once created, presumably as part of his continued desire to be consistent with the teachings of the church. There does not appear to be any way to interpret this in terms of modern physics.

[48] Leibniz's original. His primitive concepts may appear unfamiliar. However, they are consistent with modern dynamics. The dynamic nature of modes must be grounded in some disposition or power, even if this remains ineffable. Knowledge, in its simplest form, can also be interpreted as a form of dynamic relation – or for Leibniz perception. For a negative charge to move away from another negative charge there must be some communication (in the form of photons) that will provide 'knowledge' of the other charge for the first. There must also be a tendency to respond, which is covered by Will. Thus Leibniz is indicating that the dynamic relations of physics are none other than the combined essence of perception and appetition. What is not yet made clear is that the sort of knowledge we think of as being 'about' something (i.e. 'intentional' in the special sense attributed to Brentano) is more complex than this, requiring multiple paths of interaction to allow the dynamics of distant events to be inferred. This more complex form of knowledge is touched on by Leibniz in premise 25 but is otherwise not elaborated. Leibniz does, however, distinguish a yet higher form of knowledge, which he calls Reason, in which general truths can be inferred – what might be called abstract knowledge Thus, to know about something almost certainly requires not one but at least two dynamic relations and the sort of sophisticated knowledge we are familiar with probably requires a very large number of such relations.

49. A created thing is said to act outwardly in so far as it restores perfection, **or symmetry,** to the Universe, and to be passive, in relation to another, in so far as it influenced by this restoration of perfection**, or symmetry. In this way, massless monads of force tend to appear active and monads with mass (inertia) passive.** Activity is also attributed to a monad, in so far as it has distinct and rich perceptions, and passivity in so far as its perceptions are confused or limited. **In this sense the most active of monads are listeners, rich in perceptions arising from memory. These are modes of massless elastic forces of aggregate form, inseparable from the matter from which they derive clear perceptions and through which they transmit their rational actions.** [49]

49. La créature est dite agir au dehors en tant qu'elle a de la perfection, et pâtir d'une autre en tant qu'elle est imparfaite. Ainsi l'on attribue l'action à la Monade en tant qu'elle a des perceptions distinctes, et la passion en tant qu'elle en a de confuses.

50. And one created thing is more perfect than another, in this, that there is found in the more perfect that which serves to explain a priori what takes place in the less perfect, and it is on this account that the former is said to act upon the latter.[50]

50. Et une créature est plus parfaite qu'une autre en ce, qu'on trouve en elle ce qui sert à rendre raison a priori de ce qui se passe dans l'autre, et c'est par là, qu'on dit, qu'elle agit sur l'autre.

51. But in simple substances the influence of one monad upon another is only notional, and it can have its effect only through the mediation of the Necessary Being, in so far as the Necessary Being, in regulating other monads from the beginning of things, should have regard to that one monad. For since one created monad cannot have any mechanical influence upon the inner being of another, it is only by this means that the one can be dependent upon the other.[51]

51. Mais dans les substances simples ce n'est qu'une influence idéale d'une Monade sur l'autre, qui ne peut avoir son effet que par l'intervention de Dieu, en tant que dans les idées de Dieu une Monade demande avec raison, que Dieu en réglant les autres dès le commencement des choses, ait égard à elle. Car puisqu'une Monade créée ne saurait avoir une influence physique sur l'intérieur de l'autre, ce n'est que par ce moyen, que l'une peut avoir de la dépendance de l'autre.

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[49] Leibniz here appears to be making the important point that there is no absolute distinction between active and passive. Everything follows the same principles but we tend to consider some things as more active than others because of certain asymmetries in they way things relate under specific circumstances. Activity tends to be associated with animacy and with ourselves. A suggested mode type for listeners has been added.

[50] Leibniz's original. It may not be clear quite what this adds, but it appears to be in the same vein as the last premise.

[51] This premise may be useful in that it suggests that the most direct 'interactions' between 'physical' dynamic units cannot, in fact, be given a 'mechanical' description. In modern physics this is very much the case. The interaction between two 'particles', as James Ladyman points out, is not a 'micro-banging'. It is merely a mutual modification of progression, or progression in harmony. Leibniz presages this modern view in his desire to replace the idea of matter with that of force or action. Leibniz's text also emphasizes the fact that this harmonious progression is very much part of a progression of the universe as a whole. It is in a sense merely the harmony of ripples on a single surface. It may call into question the validity of a 'many body problem' in the sense that it suggests that a monad only interacts with *everything*, which might fit, in modern physics equations, with a mode relating to a universal field of potentials.

52. Accordingly, among created things, activities and passivities are mutual. For the Necessary Being, relating two simple substances, finds in each reasons which require them to adapt the other to it, and consequently what is active in certain respects is passive from another point of view; active in so far as what we distinctly know in it serves to explain what takes place in another, and passive in so far as the explanation of what takes place in it is to be found in that which is distinctly known in another.[52]

53. Now, **as unconstrained, or infinite, the Necessary Being will encompass an** infinite number of possible universes, and as only one of them can be actual, there must be a sufficient reason for this.[53]

54. And this reason can be found only in the fitness, or in the degrees of perfection as defined by the Universal laws, that these worlds possess, since each possible thing has the right to aspire to existence in proportion to the amount of perfection it contains in germ.[54]

55. Thus the actual existence of the best that the Universal laws of probability describe is due to this, that these laws make it certain.[55]

52. Et c'est par là, qu'entre les créatures les actions et passions sont mutuelles. Car Dieu, comparant deux substances simples, trouve en chacune des raisons, qui l'obligent à y accommoder l'autre; et par conséquent ce qui est actif à certains égards, est passif suivant un autre point de considération: actif en tant, que ce qu'on connaît distinctement en lui, sert à rendre raison de ce qui se passe dans un autre, et passif en tant, que la raison de ce qui se passe en lui, se trouve dans ce qui se connaît distinctement dans un autre.

53. Or, comme il y a une infinité d'univers possibles dans les Idées de Dieu et qu'il n'en peut exister qu'un seul, il faut qu'il y ait une raison suffisante du choix de Dieu, qui le détermine à l'un plutôt qu'à l'autre.

54. Et cette raison ne peut se trouver que dans la convenance, dans les degrés de perfection, que ces Mondes contiennent, chaque possible ayant droit de prétendre à l'existence à mesure de la perfection qu'il enveloppe.

55. Et c'est ce qui est la cause de l'existence du Meilleur, que la sagesse fait connaître à Dieu, que sa bonté le fait choisir, et que sa puissance le fait produire.

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[52] Leibniz's original. This premise reiterates the idea of number 49.

[53] Leibniz's original with minor modification. Leibniz does not indicate what 'actual' means but if it implies 'known' or 'perceived' the justification for this claim may become stronger.

[54] Leibniz's orgiginal

[55] These premises continue the argument in number 40, raising the issue of a Multiverse (not to be confused with 'Many Worlds'). Leibniz's idea of fitness is vague but modern physics probably shares the motivation of finding a rationale for a universe with our parameters. Leibniz's suggestion that realities in a sense 'compete for existence' on the basis of fitness may be surprisingly close to the principles of thermodynamics and quantum field theory, in which, for example, energy bearing modes appear to 'compete on an equal basis' for an equal proportion of available energy and light travels in straight lines because all the other possibilities 'interfere' with each other. Leibniz's comment that what actually exists is certain to exist may seem overstrong but elsewhere he modulates this, in line with modern physics, to allow that there are at times possibilities of equal weight such that the detailed state of the universe is not totally predetermined. What he appears to be more concerned with here is the pattern of laws that apply in this actual universe. As indicated above his analysis appears to be a reasonable mix of what is 'most possible' and what might be called an anthropic knowledge principle in which our state of knowledge can only be possible in a universe that provides for that knowledge. It may well be that knowledge of our sort requires very specific parameters that allow matter to aggregate in ways that can be associated with listeners capable of sustaining that knowledge.

56. Now this connection or adaptation of all created things to each and of each to all, means that each monad has relations which express all the others, and, consequently, that a monad is a perpetual living mirror of the universe.[56]

57. And as the same town, looked at from various sides, appears quite different and becomes as it were numerous in aspects; even so, as a result of the unlimited number of monads, it is as if there were so many different universes, which, nevertheless are nothing but aspects of a single universe, according to the special point of view of each monad.[57]

56. Or cette liaison ou cet accommodement de toutes les choses créées à chacune, et de chacune à toutes les autres, fait que chaque substance simple a des rapports qui expriment toutes les autres, et qu'elle est par conséquent un miroir vivant perpétuel de l'univers.

57. Et comme une même ville regardée de différents côtés paraît toute autre et est comme multipliée perspectivement; il arrive de même, que par la multitude infinie des substances simples, il y a comme autant de différents univers, qui ne sont pourtant que les perspectives d'un seul selon les différents points de vue de chaque Monade.

[56] Leibniz's original. The idea that the monad somehow reflects the whole universe may appear redundant or overreaching. However, it may have some relevance to the way modes in modern physics reflect both other local modes and the state of the entire universe. The modes that inhabit macroscopic objects depend in various ways on the aggregated modes that give rise to the form of the object. The types of mode that are possible depend on the density of energy in the locality or the universe. Thus, shortly after the Big Bang it is thought that the modes associated with the condensed matter we are familiar with now could not exist. All sorts of modes, including those of solid matter and of electromagnetic radiation may depend on temperature. It may seem hard to justify the idea that each monad somehow reflects even distant events in the universe. Nevertheless, modern physics suggests that this sort of relation does in fact apply, even if in terms of more or less infinitesimal possibilities of, for instance, the passage of energy via electromagnetic radiation. The probability densities given by the equations of quantum theory generally have no absolute boundaries.

[57] Leibniz's original. Leibniz brings out the fact that we would expect the universe to be perceived in different ways by different monads. Further interpretation may be inappropriate but there is a suggestion that Leibniz here is aware of the paradoxes inherent in the idea of an infinite universe. Modern cosmology suggests that the universe may be finite in terms of its size and energy content, yet could never be found to have 'edges'. This raises the possibility that the way the universe is, is dependent on from where it is perceived in a much more radical and counterintuitive way than even the observer-relative nature of the metrics of time and space suggest. What is perhaps most important in Leibniz's account is the emphasis on dynamic relation. The monad exists as an indivisible dynamic relation to *its* universe. Inasmuch as there are no constraints on how many monadic points of view there may be, there may indeed be no constraint on the 'number of universes'.

58. And by this means there is obtained as great variety as possible, along with the greatest possible order; that is to say, it is the way to get as much perfection as possible.[58]

59. Besides, no hypothesis but this (which I venture to call proved) fittingly exalts the greatness of the Universal laws of harmony.[59]

60. Further, in what I have just said there may be seen the reasons a priori why things could not be otherwise than they are. For the Necessary Being, in regulating the whole, has regard to each monad, whose nature being to represent, cannot be confined to the representing of only one part of things; although it is true that this representation is merely confused as regards the variety of particular things in the whole universe, and can be distinct only as regards a small domain of things, namely, those which are either nearest or greatest in relation to each of the monads. It is not as regards their object, but as regards the different ways in which they have knowledge of their object, that the monads are limited. In a confused way they all strive after the **symmetrical** and unconstrained, the whole; but they are limited and differentiated through the degrees of their distinct perceptions.[60]

58. Et c'est le moyen d'obtenir autant de variété qu'il est possible, mais avec le plus grand ordre qui se puisse, c'est-à-dire c'est le moyen d'obtenir autant de perfection qu'il se peut.

59. Aussi n'est-ce que cette hypothèse (que j'ose dire démontrée) qui relève, comme il faut, la grandeur de Dieu; c'est ce que Monsieur Bayle reconnut lorsque, dans son Dictionnaire (article Rorarius), il y fit des objections, où même il fut tenté de croire, que je donnais trop à Dieu, et plus qu'il n'est possible. Mais il ne put alléguer aucune raison pourquoi cette harmonie universelle, qui fait que toute substance exprime exactement toutes les autres par les rapports qu'elle y a, fût impossible.

60. On voit d'ailleurs dans ce que je viens de rapporter, les Raisons a priori pourquoi les choses ne sauraient aller autrement. Parce que Dieu en réglant le tout a un égard à chaque partie, et particulièrement à chaque Monade, dont la nature étant représentative, rien ne la saurait borner à ne représenter qu'une partie des choses; quoiqu'il soit vrai, que cette représentation n'est que confuse dans le détail de tout l'univers, et ne peut être distincte que dans une petite partie des choses, c'est-à-dire dans celles, qui sont ou les plus prochaines ou les plus grandes par rapport à chacune des Monades; autrement chaque Monade serait une Divinité. Ce n'est pas dans l'objet, mais dans la modification de la connaissance de l'objet, que les Monades sont bornées. Elles vont toutes confusément à l'infini, au tout, mais elles sont limitées et distinguées par les degrés des perceptions distinctes.

[58] Leibniz's original. Perhaps the key point Leibniz is making is that what is must be what is possible and therefore any thought that there might be more variety or order than there is must be an illusion. The idea that what is must be based on the combination of all possible variations of dynamic mode and the ordered structure of symmetries from which these may be derived is very consistent with field theory

[59] An abbreviated version of Leibniz's original without reference to Bayle.

[60] Leibniz's original refers to 'parts' of the universe in a way that seems redundant and a little inconsistent. The sentence now just refers to monads. Leibniz's claim that each monad relates to the whole universe probably has considerable merit. Nevertheless, he realized that there are limitations to what a monad may know clearly. This would now be considered partly in terms of the speed of light and light cones. There are also more complex issues about the way knowledge must make use of comparison and inference (see appendix for further treatment).

61. And compounds in this respect **reflect the dynamics of their simple substances through what we may call efficient causes**. For all is a plenum (and thus all matter is connected together) and in the plenum every motion can be said to have an effect upon distant bodies in proportion to their distance, so that each body not only is affected by those which are in contact with it and in some way feels the effect of everything that happens to them, but also is mediately affected by bodies adjoining those with which it itself is in immediate contact. Wherefore it follows that this inter-communication of things extends to any distance, however great. And consequently every body feels the effect of all that takes place in the universe.[61]

62. Thus, although each created monad represents the whole universe, it represents more distinctly the domain or body that specially pertains to it; and as this domain expresses the whole universe through the connection of all matter in the plenum, **a listener** also represents the whole universe in representing its domain of body, which belongs to it in a special way.[62]

[61] Leibniz's original claim that compounds resemble simple substances in their behaviour has been modified to avoid potential confusion. Leibniz has moved into the language of efficient cause here, talking of effects of one thing on another. He no longer talks in terms of progression in harmony (shifting reference frame without perhaps making this clear to the reader.) The new interpretation makes this distinction more explicit and gives it a specific place in the overall metaphysical structure. This premise in the original also includes a claim that every monad contains enough information for an all-seeing observer to find in it an account of the whole universe. This seems unjustifiable and has been omitted. Moreover, in modern local physics all relations to distant elements of the universe must be indirect. This does not, however, negate the valid point that all modes in the universe are directly or indirectly dependent on the state of the universe as a whole.

[62] The original premise includes a claim that a soul is the entelechy of a body. As indicated later, the new interpretation suggests a more complex relation between monads of the listener form and a human body.

61. Et les composés symbolisent en cela avec les simples. Car comme tout est plein, ce qui rend toute la matière liée, et comme dans le plein tout mouvement fait quelque effet sur les corps distans à mesure de la distance, de sorte que chaque corps est affecté non seulement par ceux qui le touchent, et se ressent en quelque façon de tout ce qui leur arrive, mais aussi par leur moyen se ressent de ceux qui touchent les premiers dont il est touché immédiatement: il s'ensuit, que cette communication va à quelque distance que ce soit. Et par conséquent tout corps se ressent de tout ce qui se fait dans l'univers; tellement que celui, qui voit tout, pourrait lire dans chacun ce qui se fait partout et même ce qui s'est fait ou se fera, en remarquant dans le présent ce qui est éloigné, tant selon les tems que selon les lieux: σύμπνοια πάντα, disait Hippocrate. Mais une âme ne peut lire en elle-même que ce qui y est représenté distinctement; elle ne saurait développer tout d'un coup tous ses replis, car ils vont à l'infini.

62. Ainsi quoique chaque monade créée représente tout l'univers, elle représente plus distinctement le corps, qui lui est affecté particulièrement et dont elle fait l'Entéléchie; et comme ce corps exprime tout l'univers par la connexion de toute la matière dans le plein, l'âme représente aussi tout l'univers en représentant ce corps, qui lui appartient d'une manière particulière.

63. The living matter belonging to a monad constitutes along with the entelechy itself what may be called a life unit. **For a listener this is a nerve cell.** Now this domain of living being or of a cell is always organic; for, as every monad is, in its own way, a mirror of the universe, and as the universe is ruled according to a perfect order, there must also be order in that which represents it**, i.e. in the perceptions of a listener, and consequently there must be order in the cell, through which the universe is represented in the listener. Other monads are associated with the entire body of an animal or man, but these are merely ordinary monads. Listeners exist in individual nerve cells so that the body is associated with a multitude of such cellular listeners, forming an audience for the living story of the being.**[63]

63. Le corps appartenant à une Monade, qui en est l'Entéléchie ou l'Âme, constitue avec l'Entéléchie ce qu'on peut appeler un vivant, et avec l'âme ce qu'on appelle un animal. Or ce corps d'un vivant ou d'un animal est toujours organique; car toute Monade étant un miroir de l'univers à sa mode, et l'univers étant réglé dans un ordre parfait, il faut qu'il y ait aussi un ordre dans le représentant, c'est-à-dire dans les perceptions de l'âme et par conséquent dans le corps, suivant lequel l'univers y est représenté.

64. Thus the organic domain of each living being is a kind of living machine or natural automaton, which surpasses all artificial automata. For a machine made by the skill of man is not a machine in each of its parts. Natural machines have parts that are in themselves machines that create and maintain the greater machine.[64]

64. Ainsi chaque corps organique d'un vivant est une espèce de Machine divine, ou d'un automate naturel, qui surpasse infiniment tous les automates artificiels. Parce qu'une Machine, faite par l'art de l'homme, n'est pas Machine dans chacune de ses parties, par exemple la dent d'une roue de laiton a des parties ou fragmens, qui ne nous sont plus quelque chose d'artificiel et n'ont plus rien qui marque de la machine par rapport à l'usage, où la roue était destinée. Mais les machines de la nature, c'est-à-dire les corps vivans, sont encore machines dans leurs moindres parties jusqu'à l'infini.

[63] Leibniz makes clear here that monads are associated with material structures. However, they are not in themselves the aggregates of parts that constitute these structures in material terms. The monad is the 'substantial form' that exists in harmony with the aggregate. Leibniz's concept of 'indistinct' representation may perhaps be equated with indirectness of relation. There is, however, a paradox in that perceptions that are *about* distant events in the universe and thereby provide knowledge of those events must be indirect in order for the dynamic nature of those events to be inferred. Immediate relations to local events may be 'distinct' in the sense of being immediate but do not entail knowledge of the immediate environment – we know almost nothing about the inside of the body. There is a complexity here that Leibniz does not address, as discussed further in the appendix. The premise has been expanded to include the idea of an audience of cellular listeners.

[64] Leibniz was impressed by the relatively recent discovery that living bodies are made of cellular units and that even water contains microscopic organisms. This led him to believe that further generations of living structures existed at ever smaller levels. We now have reason to think that this is not so, that the number of levels is finite. Leibniz's point that living bodies are composed of elements that are themselves living units fits very well with the new interpretation of the role of a multitude of listeners in a body. However, the original motivation for this observation by Leibniz may no longer be as important as it seemed at the time.

65. And the Necessary Being has been able to employ this wonderful power of art, because each portion of matter **is associated with monads at all scales of structure,** of which each has some motion of its own. **Thus in a living body there are monads at the scale of atoms, of molecules and subcellular structures, at the scales of cells, of organs and of the whole. The level of perception of each type of monad is different and it is claimed here that it is the monads associated with certain nerve cells that are the listeners with the most heightened perception or consciousness. Monads consisting of modes of force of aggregate form for the whole body do not have heightened perception since they are not furnished with complex pattens of signals integrated by the nervous system, but merely with gross mechanical forces relating to posture andd movement.**[65]

65. Et l'auteur de la nature a pu practiquer cet artifice Divin et infiniment merveilleux, parce que chaque portion de la matière n'est pas seulement divisible à l'infini, comme les anciens l'ont reconnu, mais encore sous-divisée actuellement sans fin, chaque partie en parties, dont chacune a quelque mouvement propre: autrement il serait impossible que chaque portion de la matière pût exprimer tout l'univers.

66. Whence it appears that in the smallest particle of matter **visible with the naked eye** there can be a world of creatures, living beings, animals, entelechies, simple monads or listeners.[66]

66. Par où l'on voit, qu'il y a un Monde de Créatures, de vivans, d'animaux, d'Entéléchies, d'âmes dans la moindre partie de la matière.

67. Each portion of matter may be conceived as like a garden full of plants and like a pond full of fishes.[67]

67. Chaque portion de la matière peut être conçue comme un jardin plein de plantes, et comme un étang plein de poissons. Mais chaque rameau de la plante, chaque membre de l'animal, chaque goutte de ses humeurs est encore un tel jardin ou un tel étang.

[65] This premise has been expanded to clarify the idea that the monads with the most heightened perception that Leibniz called souls are likely to be multiple in animals and man and to be associated with cells rather than the whole body.

[66] This premise has been modified to remove the implication that subdivision of matter into smaller and smaller scales of monads is likely to go on to infinity in the way Leibniz envisaged. This and the next few premises make it clear that Leibniz takes a panexperientialist view in which all elements of the Universe perceive in some way.

[67] This rather poetic premise may now seem redundant but it does crystallize an idea that will be central to later issues of causation and ethics. Leibniz's idea is that monadic units that have their own entelechies, final causes or anticipations, exist in assciation with all scales of matter. Put another way the dynamic units at scales we cannot even see may be considered just as 'alive' as larger bodies, and perhaps more so.

68. And though the earth and the air which are between the plants of the garden, or the water which is between the fish of the pond, be neither plant nor fish; yet they also contain perceiving monads, but mostly so minute as to be imperceptible to us.[68]

69. Thus there is nothing fallow, nothing sterile, nothing dead in the universe, no chaos, no confusion save in appearance, somewhat as it might appear to be in a pond at a distance, in which one would see a confused movement and, as it were, a swarming of fish in the pond, without separately distinguishing the fish themselves.[69]

70. Hence it appears that each living body is full of other living beings, each of which has its dominant entelechy or, in some cases, **listener**.[70]

71. But it must not be imagined, as has been done by some who have misunderstood my thought, that each monad **or listener** has a quantity or portion of matter belonging exclusively to itself or attached to it for ever. For all bodies are in a perpetual flux like rivers, and parts are entering into them and passing out of them continually.[71]

68. Et quoique la terre et l'air interceptés entre les plantes du jardin, ou l'eau interceptée entre les poissons de l'étang, ne soient point plante ni poisson, ils en contiennent pourtant encore, mais le plus souvent d'une subtilité à nous imperceptible.

69. Ainsi il n'y a rien d'inculte, de stérile, de mort dans l'univers, point de chaos, point de confusions qu'en apparence; à peu près comme il en paraîtrait dans un étang à une distance, dans laquelle on verrait un mouvement confus et grouillement pour ainsi dire de poissons de l'étang, sans discerner les poissons mêmes.

70. On voit par là, que chaque corps vivant a une Entéléchie dominante qui est l'âme dans l'animal; mais les membres de ce corps vivant sont pleins d'autres vivans, plantes, animaux, dont chacun a encore son Entéléchie ou son âme dominante.

71. Mais il ne faut point s'imaginer avec quelques-uns, qui avaient mal pris ma pensée, que chaque âme a une masse ou portion de la matière propre ou affectée à elle pour toujours, et qu'elle possède par conséquent d'autres vivans inférieurs, destinés toujours à son service. Car tous les corps sont dans un flux perpétuel comme des rivières, et des parties y entrent et en sortent continuellement.

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[68] Leibniz's original.
[69] Leibniz's original.
[70] Leibniz's original, with listener for dominant soul.
[71] Largely Leibniz's original. He makes the important point that a soul (or now listener) is associated with an aggregate of matter but is not the sum of that aggregate and is not dependent on any particular atom or molecule being present in that aggregate. The listener is associated with the asymmetry that is the relation of the aggregate to the universe. That asymmetry may not be significantly changed by exchange of its individual components for similar ones. This has direct relevance to the modes associated with ordered structures in modern physics.

72. Thus the body associated with a listener changes only by degrees, little by little, so that it is never all at once deprived of all its organs; and there is growth and even metamorphosis in animals, but never metempsychosis or transmigration of 'souls' or listeners; nor are these ever entirely separate from bodies. **All that must be continuous for the continued heightened perception of a listener, together with others forming an audience, is a form of organization of the body that transmits signals from the outside world in such a way as to provide a clear and distinct picture of that world. This is the nexus of Whitehead. It has essential structural features with very diverse functions: nutrition, sensory input, memory store and many others. This complex facilitating structure is in a sense the theatre for the audience of listeners, including the players, the stage, and the seats that the listeners occupy. This entire functional system can be called a theatre of heightened perception.**[72]

72. Ainsi l'Âme ne change de corps que peu à peu et par degrés, de sorte qu'elle n'est jamais dépouillée tout d'un coup de tous ses organes; et il y a souvent métamorphose dans les animaux, mais jamais Métempsychose, ni transmigration des Âmes: il n'y a pas non plus des âmes tout à fait séparées, ni de génies sans corps. Dieu seul en est détaché entièrement.

73. It also follows from this that there never is absolute generation from nothing. There is no 'moment of conception' since all life evolves from prior forms of life. The audience is inseparable from the theatre that provides its living story. The complexity of the perceptions of listeners develop in richness as the body and the theatre develop. **Each listener is a transient occasion. What persists is the living story narrated within the theatre and in a sense it is the theatre that is the enduring individual. Even after death something of the same story may be known to listeners in association with other bodies and their theatres.**[73]

73. C'est ce qui fait aussi qu'il n'y a jamais ni génération entière, ni mort parfaite prise à la rigueur, consistant dans la séparation de l'âme. Et ce que nous appelons générations sont des développements et des accroissements; comme ce que nous appelons morts, sont des enveloppements et des diminutions.

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[72] Leibniz's original brief premise has been expanded to develop the idea that the monads of our apperception or consciousness derive that apperception from the supportive role of a complex functional system that will be called a theatre. The detail may change but the functional system must continue to function in a certain way if apperception is to be clear.

[73] Leibniz's original premise is designed to support the idea of an immortal soul but yet to explain that there is no separation of soul and body. Leibniz's account is hard to follow and is rather different in in *Principles of Nature and Grace.* If monads are considered as brief occasions, as in Whitehead, the issues become different. Where Leibniz's premise appears to remain relevant is in pointing out that 'persons' or 'souls' do not suddenly appear out of nowhere or disappear. In his day it is likely that many people thought that life appeared by spontaneous generation from what Leibniz calls chaos or putrefaction. The new interpretation begins to open a division between the raw ontology of dynamic units and the essence of a human being, which is now seen more in terms of a 'living story'. This division is seen later as an important source of our confusion about the nature of cause and its ethical implications. Leibniz's infrastructure remains very relevant, but its application takes on a new significance.

74. Philosophers have been much perplexed about the origin of forms, entelechies, or souls; but nowadays it has become known, through careful studies of plants, insects, and animals, that the organic bodies of nature are never products of chaos or putrefaction, but always come from seeds, in which there was undoubtedly some preformation; and it is held that not only the organic cell was already there before conception, but also monads of form in this cell.[74]

74. Les philosophes ont été fort embarrassés sur l'origine des formes, Entéléchies ou Âmes: mais aujourd'hui lorsqu'on s'est aperçu par des recherches exactes, faites sur les plantes, les insectes et les animaux, que les corps organiques de la nature ne sont jamais produits d'un Chaos ou d'une putréfaction, mais toujours par des semences, dans lesquelles il y avait sans doute quelque préformation, on a jugé que non seulement le corps organique y était déjà avant la conception, mais encore une âme dans ce corps et en un mot l'animal même, et que par le moyen de la conception cet animal a été seulement disposé à une grande transformation pour devenir un animal d'une autre espèce. On voit même quelque chose d'approchant hors de la génération, comme lorsque les vers deviennent mouches et que les chenilles deviennent papillons.

75. Of these cells, some, through the means of conception, multiply to give rise to the cellular aggregates of larger animals. Others that are not so raised but remain in their own kind (that is, the majority) are born, multiply, and are destroyed like the large animals, and it is only a few chosen ones that become members of a body constituting a theatre, with heightened perceptions made possible.[75]

75. Les animaux, dont quelques uns sont élevés au degré de plus grands animaux par le moyen de la conception, peuvent être appelés spermatiques; mais ceux d'entre eux qui demeurent dans leur espèce, c'est-à-dire la plupart, naissent, se multiplient et sont détruits comme les grands animaux, et il n'y a qu'un petit nombre d'élus, qui passe à un plus grand théâtre.

76. But this is only half of the truth. **It seems that our conception of an 'animal' may be too simple and confused. An 'animal' is not so much a material unit as a living story that can have no absolute beginning or end. Even if the theatre changes the story narrated may in a sense continue. Myriads of monads contribute to the story and a multitude will hear it.[76]**

76. Mais ce n'était que la moitié de la vérité: j'ai donc jugé, que si l'animal ne commence jamais naturellement, il ne finit pas naturellement non plus; et que non seulement il n'y aura point de génération, mais encore point de destruction entière ni mort prise à la rigueur. Et ces raisonnements faits a posteriori et tirés des expériences s'accordent parfaitement avec mes principes déduits a priori comme ci-dessus.

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[74] Leibniz's original, omitting some of his examples.

[75] Leibniz's premise has been modified but it is interesting that even in the original Leibniz draws the analogy of a 'greater theatre' for those cells forming complex multicellular organisms.

[76] Leibniz's desire for continuity is respected but now achieved by a shift away from material units to patterns of dynamics. This is a major change from Leibniz's own view but it preserves the relational dynamic spirit of his approach in a way that perhaps he might have approved of in a modern context?

77. Thus it could be said that both a **listener** and an animal are indestructible. The listener is an occasion that occurs at its allotted time through the laws of harmony of the universe. An occasion cannot be destroyed. The animal is the persisting living story of a complex aggregate of monads that may move from theatre to theatre or may cease to be told, but cannot be destroyed.[77]

78. These principles have given us a way of explaining naturally the union, or better the mutual agreement, of **audience** and organic body. Each listener follows its own laws, and the body likewise follows its own laws; and they agree with each other in virtue of the pre-established harmony between all substances, since they are all representations of one and the same universe.[78]

79. Monads act according to the laws of final causes through appetitions, ends, and means. **These final causes that guide monads entail within themselves formal causes constituted by the state of the universe with which the monad is in harmony**. Bodies act according to the laws of efficient causes or motions. And the two realms, that of efficient causes and that of final causes, are in harmony with one another. **This can be seen in modern physics. Immediate or fundamental interactions, those of monads or modes, show an intrinsic entelechy or necessary progression that shows 'anticipation' in that the mode itself is detemined as much by its final as its initial conditions. In contrast, the mediated interactions of aggregates behave differently, as described by 'classical' physics, through trajectories, despite these being no more than the resultant of the progression of monadic elements.**[79]

77. Ainsi on peut dire que non seulement l'âme (miroir d'un univers indestructible) est indestructible, mais encore l'animal même, quoique sa machine périsse souvent en partie et quitte ou prenne des dépouilles organiques.

78. Ces principes m'ont donné moyen d'expliquer naturellement l'union, ou bien la conformité, de l'âme et du corps organique. L'âme suit ses propres loix, et le corps aussi les siennes; et ils se rencontrent en vertu de l'harmonie préétablie entre toutes les substances, puisqu'elles sont toutes les représentations d'un même univers.

79. Les âmes agissent selon les loix des causes finales par appétitions, fins et moyens. Les corps agissent selon les loix des causes efficientes ou des mouvemens. Et les deux règnes, celui des causes efficientes et celui des causes finales sont harmoniques entre eux.

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[77] Leibniz's premise that there is no true generation or destruction is given a new interpretation.

[78] Leibniz's conclusion to this section is retained because the underlying conception of monads at different levels progressing in harmony remains the core dynamic concept despite other changes in interpretation.

[79] Leibniz introduces a schema for causation that is remarkably prescient of modern physics. He has deduced that it is only monadic elements that show the remarkable capacity to 'anticipate' in their progression, as if they are able to 'choose' their future. This might seem far-fetched in the context of traditional mechanics but physics has shown that immediate interactions behave very differently from the way we consider the everyday world to behave. However, for an aggregate body this anticipation is lost, behaving as if with no idea where it is going until it gets there. It operates purely by trajectory, as billiard balls and levers do. That these two forms of dynamics seemed necessary for seventeenth century thinkers like Leibniz suggests that we should perhaps not be so surprised by similar aspects of modern physics. The mystery is why they appeared necessary in the past and why this sense had been lost in relatively more recent times.

This premise is the basis of what has misleadingly been called 'psychophysical paralellism' in Leibniz. It is unclear that Leibniz would have recognized 'psychological' and 'physical' as categories. The harmonization of causes described here is a subtler duality relating to the distinction between substances and aggreagates, close to the modern correspondence principle.

80. Descartes believed that souls or spirits cannot impart any force to bodies, because there is always the same quantity of force in matter. Nevertheless he was of opinion that the soul could change the direction of bodies. **It is true that a net change could not occur because of conservation of momentum. However, *pace* Leibniz, this is no argument against a soul causing a *redistribution of motion* within an aggregate of bodily monads. If 'soul monads' or listeners are the massless modes of elastic or acoustic force of physics there is no need to invoke anything outside physics in this regard. That 'interactionism' was a problem for reasons of conservation is a misconception. Moreover, now that both modes of force and modes capable of aggregating as 'matter' are recognized the charge of 'non-physical dualism' becomes empty. Any duality is one of several *within* physics. The relation across this duality is well described as pre-established harmony because the progression of the listener entails the motion of the body it is associated with and vice versa. Neither can occur without the other and there is no mechanical mediation between the two. This is the position of modern physics. All symmetries of material form entail modes of elastic force and vice versa.**[80]

80. Des Cartes a reconnu, que les âmes ne peuvent point donner de la force aux corps, parce qu'il y a toujours la même quantité de force dans la matière. Cependant il a cru que l'âme pouvait changer la direction des corps. Mais c'est parce qu'on n'a point su de son tems la loi de la nature, qui porte encore la conservation de la même direction totale dans la matière. S'il l'avait remarquée, il serait tombé dans mon système de l'Harmonie préétablie.

81. This system makes it appear that bodies behave *as if* there were no associated monad of form or listener and vice versa but the two together behave *as if* influencing each other. **(Thus the sea appears to behave as an aggregate of water molecules, irrespective of any extra 'wave entities' and waves appear to behave as waves do, irrespective of the identity of the water molecules, yet the sea also appears to influence the waves and vice versa. In physics both are equally real and entail each other.**[81]

81. Ce système fait, que les corps agissent comme si (par impossible) il n'y avait point d'Âmes, et que les Âmes agissent comme s'il n'y avait point de corps, et que tous deux agissent comme si l'un influait sur l'autre.

[80] Leibniz's famous disagreement with Descartes is reassessed, with the conclusion that there was never a problem of interactionism violating physics.

[81] Leibniz's original premise is retained with an approach to the translation that is seen as reflecting best his true intention. Leibniz appears to be saying 'yes, I know it seems contradictory but at the fundamental level immediate (unmediated) relations work in this strange harmonious way'. The relation between the sea and waves is given as an example. As indicated in the appendix, Lebniz's account appears to be a very reasonable stab at an account of some of the most difficult issues of modern condensed matter physics.

82. **There is something unique about listeners, in that cells, with which these are associated, of themselves only posess ordinary or sensitive monads-of-form with indistinct perceptions of the world. But as soon as those that are of the elect, so to speak, develop through growth and differentiatiation into those cells within the nervous system that take on a complex form and are furnished with a complex theatre, they are raised to the level of reason by dint of the complex information they receive and the way in which it is received and responded to.**[82]

83. Among other differences which exist between ordinary monads and listeners, some of which I have already noted, there is also this: that monads in general are living mirrors or images of the Universe of created things, but that listeners also make use of the Universal rules of knowledge. **Without perception nothing can be real because reality is nothing other than being involved in the relation of perception. Without heightened perception nothing can be known. Only a universe based on laws of knowledge can include listeners that are *knowers*. Knowledge provides for the possibility of imitation and the creation of forms that would not occur spontaneously, from a simple bird's nest to a cathedral. Thus it may appear that within each body there is a little divinity within its own sphere. This 'inner universe' is the living story both played out and experienced by the ever-changing audience of listener-monads within the cells that comprise the theatre of the nervous system**.[83]

[82] This premise (here couched in modern biology) is the most explicit indication that Leibniz saw soul-monads as associated with cells (or 'spermatic animals'). In man these are 'elevated' to the level of rational souls. Leibniz's attempts to provide an account of monads as enduring entities draws on the idea that what continues is the presence of cells. In the 'spermatic' case these exist separately and in the higher animal they exist as colonies. This conception that the fundamental unit that carries forward the process of life is the cell has become central to biology.

[83] Leibniz emphasizes that the monads he calls rational souls differ from others in that they can make use of knowledge and imitate the universe.

82. Quant aux Esprits ou Âmes raisonnables, quoique je trouve qu'il y a dans le fond la même chose dans tous les vivans et animaux, comme nous venons de dire, (savoir que l'Animal et l'Âme ne commencent qu'avec le monde et ne finissent pas non plus que le monde), il y a pourtant cela de particulier dans les Animaux raisonnables, que leurs petits Animaux spermatiques tant qu'ils ne sont que cela, ont seulement des âmes ordinaires ou sensitives: mais dès que ceux, qui sont élus, pour ainsi dire, parviennent par une actuelle conception à la nature humaine, leurs Âmes sensitives sont élevées au degré de la raison et à la prérogative des Esprits.

83. Entre autres différences qu'il y entre les Âmes ordinaires et les Esprits, dont j'en ai déjà marqué une partie, il y a encore celle-ci, que les âmes en général sont des miroirs vivans ou images de l'univers des créatures, mais que les esprits sont encore images de la Divinité même, ou de l'Auteur même de la nature, capables de connaître le système de l'univers et d'en imiter quelque chose par des échantillons architectoniques, chaque esprit étant comme une petite divinité dans son département.

This premise is extended and recast in keeping with the new interpretation.

84. It is this that enables **listeners** to enter into a kind of fellowship with the Necessary Being, and brings it about that in relation to them the Necessary Being may seem to be not only what an inventor is to his machine (which is the relation of the Universe to other created things), but also what the inventor is to his apprentices, or indeed a father is to his children.

Yet we must remember that however remarkable human knowledge may seem it is very partial and confused. Perhaps the relation is more like that of the playwrite and the theatre company. The playwrite provides the laws of the story but does not act out his stories except through the action of monads. These might be ordinary monads, with the story merely in the form of wind blowing through trees. They may be the neural listener/players of the human mind operating within a complex theatre. The players may come and go and even the theatre may be refurbished or reconstructed but a certain form of story, like a theatre production, may endure for years or even centuries.

In this context the final causes that drive the progression of listeners will, in some partial sense be transferred to or manifest through the efficient causes of the bodily parts. Thus a material scene or enactment may be seen to reflect final causes that are more than just the movements of inanimate matter. This may be well enough understood, but there is potential for confusion between the roles of individual evanescent listeners, the audience as a whole and the elements of the theatre formed by the structures of individual cells, their connections in a nervous system and their relation to the body as a whole. This confusion is at the heart of the paradox that we seem to live in a purely material world yet also in a 'moral' world.[84]

84. C'est ce qui fait que les esprits sont capables d'entrer dans une manière de société avec Dieu, et qu'il est à leur égard non seulement ce qu'un inventeur est à sa machine (comme Dieu l'est par rapport aux autres créatures) mais encore ce qu'un Prince est à ses sujets et même un père à ses enfants.

[84] Leibniz in this premise touches on the concept of man being made in the image of God and relating it to the presence of rational souls that can imitate the works of God through making use of knowledge. The premise has been extended with a qualification indicating that although there is some validity in this idea there is also considerable potential for drawing a false analogy between a human soul and the source of the universe. Nevertheless, the reason why this potential confusion arises is precisely because of the complexity of causality that Leibniz gives a good account of. In Leibniz's time, for reasons both of scientific humility and religious politics, it may well have seemed that the analogy between man and God should be considered more or less at face value. However, in the modern context a more complex analysis seems appropriate. And rather than rejecting Leibniz's final premises as absurd, in line with Voltaire, it is suggested that this more complex interpretation only goes to show how lasting Leibniz's analysis of causation and its relation to ethics really is.

85. Whence it is easy to conclude that the assemblage of all listeners must be the highest embodiment of the rules of knowledge, that is to say, the most perfect state that is possible, under the most perfect of rules. **This claim of perfection may appear strained in a world that we perceive as full of strife and apparently unfulfilled existence. However, if the rules of the universe were otherwise, such that human knowledge was not possible it is hard to see how we might consider it a 'better world'. And in the sense that perfection is the maximization of reality, it is knowledge above all that maximises reality for us. Confusion arises because the final causes of listeners are perceived by those listeners, and others, as if final causes of the bodies they are associated with. For each monad the final cause is implicit. If final causes, or 'purposes' are attributed to bodies it is no longer clear what they should be. Such 'purposes' will be seen to conflict. What seems an act of goodness may create misery, even within the same body. This can easily be seen as 'imperfection' in the world. Perhaps it is better to consider it in terms of the limitations of our abilities to know and understand and to recognize that even competition for existence is a basic property of the universe that allows our form of knowledge to evolve.**[85]

85. D'où il est aisé de conclure que l'assemblage de tous les Esprits doit composer la Cité de Dieu, c'est-à-dire le plus parfait État qui soit possible sous le plus parfait des Monarques.

86. This highest embodiment of the Necessary Being is a 'moral' world in the natural world, and is the most exalted **within the Universe;** and it is in it that the glory of the Necessary Being really consists, for it would have no glory were not its greatness and goodness known and admired by **listeners.** It is also in relation to this that this highest embodiment especially has the idea of goodness, while the Universal rules are manifest everywhere. **The idea of goodness arises for listeners that have some understanding of the relation of final to efficient cause.** [86]

86. Cette Cité de Dieu, cette Monarchie véritablement universelle est un Monde Moral dans le monde Naturel, et ce qu'il y a de plus élevé et de plus divin dans les ouvrages de Dieu: et c'est en lui que consiste véritablement la gloire de Dieu, puisqu'il n'y en aurait point, si sa grandeur et sa bonté n'étaient pas connues et admirées par les esprits: c'est aussi par rapport à cette Cité divine, qu'il a proprement de la Bonté, au lieu que sa sagesse et sa puissance se montrent partout.

[85] Leibniz's claim of perfection is qualified with a discussion of how it can be made consistent with the apparent imperfections we see around us.

[86] Leibniz moves from the dynamics of physics to the realm of ethics. This might be considered no longer legitimate in a modern atheistic scientific account. However, even if it is unclear how any case of the unfolding of physical dynamics in the universe could be considered 'good' or 'bad' any scientific account that claims to be comprehensive must at least explain how there comes to be a sense of good and bad. At least the experience of the affective qualities of pleasure or pain and moral judgements must have a place in the dynamic framework.

87. As we have indicated above that there is a perfect harmony between the two realms in nature, one of efficient, and the other of final causes, we should here notice also another harmony between the physical realm of nature and the moral realm of grace, that is to say, between the Necessary Being, considered as origin of mechanism, and considered as origin of the moral ideas of listeners.

The evolution of man made possible knowledge, or understanding, of these harmonies. However, it must be said that our understanding of how the physical and moral realms relate is in its infancy. Study of science and history should help us to clarify that understanding over centuries but only if individuals are prepared to recognize the magnitude of the task and the limitations of our rational faculties.

The moral realm is a realm of ideas in which it seems to us that we can apply final causes to the realm of aggregate bodies. A person is said to have a purpose, or an instrument a function. These final causes cannot be the same as the anticipations of monads since these latter are never unfulfilled, whereas the purpose of a person may seem so. It seems as if the rational power of man has evolved so that he makes this analogy, and this analogy has led to the advancement of understanding and survival of individuals with that understanding. Yet, it is clear that the analogy is only a weak metaphor. A person who seems to sense failure or pain may be considered unfulfilled, yet the listerners that in fact have this sense are never unfulfilled. It seems that although the universe has given man a sense of goodness man has still a long way to go before he learns how to apply that sense of goodness to his perceptions in a consistent way. And it seems likely that there will be no simple way to understand the harmonies involved. Only prolonged study may bring us close to it. [87]

87. Comme nous avons établi ci-dessus une harmonie parfaite entre deux Règnes naturels, l'un des causes Efficientes, l'autre des Finales, nous devons remarquer ici encore une autre harmonie entre le règne Physique de la Nature et le règne Moral de la Grâce, c'est-à-dire entre Dieu, considéré comme Architecte de la Machine de l'univers, et Dieu considéré comme Monarque de la Cité divine des Esprits.

[87] Leibniz indicates that morality is in harmony with the physical world. This may seem a tendentious claim but it is something implicit in most modern views of the world. It is assumed that what we call morality arises together with the laws of physical dynamics. The only question is whether we take the morality seriously or whether we consider it some sort of arbitrary by product. The latter approach may seem attractive initially to the 'materialist' but it rapidly leads to question begging about the whole intellectual enterprise. A lengthy addendum has been given to emphasise how little distance we are down the road, so far, to understanding what the harmony between morality and physics may be. The conclusion given is perhaps close to Spinoza's idea that the pursuit of understanding is the most valuable task in life and that it is a long and difficult road.

88. A result of this harmony is that things lead to grace by the very ways of nature. **Thus it is only through the harmonious progression of the monads that a sense of good and evil comes about. Moreover, the sense of justice and the rightness of punishment and reward has come about because it maintains the very powers of knowledge that allow the idea to be perceived. Inasmuch as there may be a useful idea of free will it is not some ability to deviate from the laws of the universe. The progression of every monad always follows those laws and only those laws. However, the conception of free will acts as a confused form of knowledge that leads to interactions between persons, based on the idea that they have something of the anticipations of monads, that maintain the qualities of man that allow at least this and potentially greater degrees of knowledge and understanding**.[88]

88. Cette harmonie fait que les choses conduisent à la Grâce par les voies mêmes de la Nature, et que ce globe par exemple doit être détruit et réparé par les voies naturelles dans les momens, que le demande le gouvernement des esprits pour le châtiment des uns et la récompense des autres.

[88] Leibniz moves from a statement of harmony of physical and moral realms to a rather stark claim about the world being just, with due punishment and reward. This has been replaced by a more complex analysis of justice that seems more consistent with a modern view. It is argued that the seeds of this view lie in Leibniz's own analysis. Whether Leibniz's own account was driven more by political correctness or genuine belief is speculative but it seems likely that, as for Descartes, genuine belief was involved. There may be an important distinction with Spinoza here, who clearly denies that there is a coherent idea of free will. Leibniz appears to retain the concept of choice or free will as an element of dynamics, although it is perhaps surprising that he does not address the paradox involved. Yet, as in several previous instances this may be a case where we are dealing with an aspect of causation that we do not yet have an adequate model of and Leibniz's arguments may be as pertinent to the ultimate solution as any others. As with Descartes it seems reasonable to suggest that genuine belief was combined with an appreciation of uncertainties that were not expressed in a formal text simply because it was considered that they would cause more confusion than enlightenment.

89. It may also be said that Universal Necessity must in some way be reflected in the laws of human behaviour. It is therefore reasonable that sins bear their penalty with them, through the order of nature, and even in virtue of the mechanical structure of things; and similarly that noble actions will attain their rewards by ways that, on the bodily side, are mechanical, although this cannot and ought not always to happen immediately. **Civilised society has to a great degree come to balance the apparent conflicts that arise in the harmony of the final causes of listeners and the efficient causes of aggregate bodies. Thus concepts of moral responsibility have been devised in terms that tend to restore harmony. However, the great success and proliferation of the human race has increased the potential for apparent conflict between the perceived requirements of aggregate bodies, harnessed by final causes of internal monads. And perhaps the success in bodily terms has outstripped the progress in understanding. It may be increasingly important for us to recognize that we do not yet fully understand how the sense of what is good truly relates to the perfection that makes that sense possible.** [89]

89. On peut dire encore, que Dieu comme architecte contente en tout Dieu comme législateur, et qu'ainsi les péchés doivent porter leur peine avec eux par l'ordre de la nature, et en vertu même de la structure mécanique des choses; et que de même les belles actions s'attireront leurs récompenses par des voies machinales par rapport aux corps, quoique cela ne puisse et ne doive pas arriver toujours sur le champ.

[89] The cautious interpretation of justice in the previous premise is continued here. The aim is to agree with Leibniz that justice has a rational place in an overall metaphysical system, yet to point out that there are difficult decisions to make in a world in which competition for resources is ever greater.

90. **Finally, under these universal laws that are those that make possible our knowledge and wonderment, injustice can only be a confusion of ideas. Everything must come out right for those who do not misunderstand these laws; who trust in the laws. This means deriving pleasure from contemplating the perfections of the universe, in accordance with the nature of genuine *pure love*, which derives pleasure from the happiness of the loved one. While we cannot fully understand how the laws of the universe work out in our perceptions we can know that love is the only guidance we have towards those confusedly perceived purposes, that resemble, yet are not quite, final causes, to which we aspire. It is this that makes wise and virtuous people work at everything that seems best to conform to the presumptive purpose of the world, and yet to be content with what actually happens under its laws. We recognise that, if we could understand the order of the universe well enough, we would find that it surpasses all the wishes of the wisest people, and that it is impossible to make it better than it is — not merely in respect of the whole in general, but also in respect of ourselves in particular. However, this will only be so if we have a proper relationship to the final cause of the Universe which must constitute the whole aim of our will, and which alone can constitute our happiness.**[90]

90. Enfin sous ce gouvernement parfait il n'y aurait point de bonne Action sans récompense, point de mauvaise sans châtiment; et tout doit réussir au bien des bons, c'est-à-dire de ceux, qui ne sont point des mécontens dans ce grand État, qui se fient à la Providence, après avoir fait leur devoir, et qui aiment et imitent comme il faut l'Auteur de tout bien, se plaisant dans la considération de ses perfections suivant la nature du pur amour véritable, qui fait prendre plaisir à la félicité de ce qu'on aime. C'est ce qui fait travailler les personnes sages et vertueuses à tout ce qui paraît conforme à la volonté divine présomtive ou antécédente, et se contenter cependant de ce que Dieu fait arriver effectivement par sa volonté secrète, conséquente et décisive, en reconnaissant, que si nous pouvions entendre assez l'ordre de l'univers, nous trouverions qu'il surpasse tous les souhaits des plus sages, et qu'il est impossible de le rendre meilleur qu'il est, non seulement pour le tout en général, mais encore pour nous mêmes en particulier, si nous sommes attachés comme il faut à l'Auteur du tout, non seulement comme à l'Architecte et à la cause efficiente de notre être, mais encore comme à notre Maître et à la cause finale qui doit faire tout le but de notre volonté, et peut seul faire notre bonheur.

[90] Leibniz's original final premise starts in the same apparently simplistic style with a statement of the justice of God and the inevitable punishment of evil and reward of good. However, as the premise continues the subtlety of his view emerges and the conclusions become hard to challenge. The emphasis on the partial nature of our understanding and the value of trying to understand more seems close to Spinoza. But in addition the claim that pure love must be at the centre of our way of living makes sense in terms of our need to make use of the sense of value that we have because our confused perceptions can only be guided by this. Many questions may remain unanswered but that is acknowleged.

Commentary

Why monads?

It may be fair to say that Leibniz's monads were designed to resolve two very different problems. These same two problems are still regarded as the most difficult in science. The first is the nature of the most basic entities of our world – assuming that there are some. The second is the relation of subjective experience, or having a point of view, to the world that is experienced. Leibniz sees early on in his career that these two problems should have a single solution, which relies on the correct definition of the fundamental units of dynamic relation. He sees them as connected because it is the existence of 'points of view' that is the most pressing argument for the existence of discrete entities in the first place (contra Spinoza). Otherwise all could be a single continuous entity.

Things might have been easier for Leibniz if instead of 'monads' he talked of atoms. He does say that his monads are the true atoms of nature, but he has good reasons to avoid the term atom. Atoms, as associated with Epicurus, Democritus and, closer to Leibniz, Gassendi, were sort of identical billiard ball Lego bricks for building matter. Even this simple metaphor suggests that this is not an idea that is going to work very easily. What shape could they be and why would they stick together? In the seventeenth century the absurdity of Democritus's atoms was well recognized. In the nineteenth century people thought they had found evidence for them – coming in different sizes called elements. But these are not atoms in the original sense. They proved to be aggregates of constituents, such as quarks, gluons and electrons.

Moreover, atoms now turn out to be quite uncommon in our universe. As I understand it, in most of the sun there are hydrogen and helium nuclei but the electrons form a diffuse plasma, so there are no atoms. And where things cool you tend to get hydrogen molecules, which are not just two Lego atoms joined, they are entirely new sorts of aggregate. The noble gas atoms that exist alone are unusual. There are no iron atoms in an iron bar. Electrical conductivity is an indication that some of the electrons are relating to all the nuclei in macroscopis modes. And so on.

We never found Democritus's atoms. And when we look at the indivisble units we do seem to have found they bear no resemblance to billiard balls or Lego bricks. They look very much like Leibniz's monads. They have no size or shape in the normal sense and no parts. Their nature appears to be simply a 'principle of change' that we characterize in terms like momentum or frequency that determine their relation to the universe.

What I find somewhat surprising about commentary on Leibniz from the scientific community is that although insights into the relative nature of space and time, conservation of energy and the dynamic nature of 'matter' are acknowledged, the extent to which Leibniz presages the basic priniciples of quantum field theory seem not to be commonly recognized. I find this surprising because I first came to read Leibniz having spent some time updating myself on quantum field theory and my immediate reaction to reading Monadology was that Leibniz was neatly describing modes of excitation of fields. There are numerous places where at first it seems that Leibniz has not got things quite right, but he is careful not to commit himself to details that he cannot confirm and on reflection it often becomes clear that he is at least not wrong and that at a basic logical level he may have a clearer account of modern physics than the modern physics textbooks themselves.

The chief difficulty that both Leibniz and his readers are faced with is the leap from the application of the theory of Monads to basic physics to its application to human subjective experience and a concept of a human 'soul'. If we continue to think of the 'atoms of nature' as being like billiard ball Lego bricks it is hard to see how a modern version like an electron could be a human soul. But this is where I think Leibniz is way out in front.

What modern field theory actually says is that there are no individual 'particles' that exist with some intrinsic identity, as in electron A, electron B and electron C. There are merely dynamic modes A,B and C that are different instances of operation of certain types of rule that stipulate things like energy content or mass or charge. Just after the Big Bang there were no modes of the sort we are familiar with, no electron or quarks modes. But after a period of time these modes 'settled out' like crystals in a cooling solution.

And in a sense they are not so much like particles as like pools of energy forming in troughs in the fabric of the universe, like water in the pockets in an ice cube tray.

It might seem from school physics that all electrons are much the same. However, the equations that describe electrons indicate that this is not at all the case. The reason for this is that the equation includes a term that indicates the field of potentials that the electron is operating in. In a sense it describes the ice tray well that the energy is sitting in. If the well of an electron mode is the vicinity of a nucleus then it is likely to be an 'orbital' of s, p or d configuration. If the well is the vicinity of a lattice of iron nuclei in a piece of metal then it will be a 'semi-free' valency electron mode that can mediate electrical conductance. It might seem that there are also 'free electron modes' as in beta rays in a cathode ray tube. However, this is merely an idealisation. In reality, every electron mode has a unique field of potentials that informs the very nature of the mode, because every electron is a relation to the universal field of potentials from a slightly different 'point of view'.

The point of all this is that every mode of excitation in the universe is infinitely complex but without parts because it is an infinitely complex relation between that mode of excitation and the universe from a unique angle. Feynman famously said of this 'there's plenty of room at the bottom'. In other words if you want complexity just look at the most fundamental entities.

Even accepting that the most fundamental dynamic units of modern physics are infinitely complex, there is, however, a general feeling that a human soul just isn't going to be a single unit (or mode), even if it were an electron in a valency mode in a metal that had a very large domain ecompassing a macroscopic object. This seems to be partly because it is assumed that a single mode would not have enough energy to dtermine behaviour and partly because it has become fashionable to think of experience arising somehow globally within the brain, or even within the body, as a 'system', despite this raising problems with the law of locality in physics.

Probably for this reason most attempts to relate human experience to quantum theory have suggested that the experience relates to a large collection of modes that are unified by what is known as 'entanglement'. This runs contrary to Leibniz's approach since this collection would be an aggregate. Each mode within the collection would have an infinitely rich relation to the universe but it is unclear in what sense the *collection* has a relation to the universe.

In fact entanglement seems to be worse than useless because what it means is correlation. If A and B are entangled then you can discover facts about A by measuring B. If A,B,C,D,E,F and G are all entangled then you only need to measure one to know about all of them. I find it very difficult to see how this helps. It seems to indicate that there is less information present than if A-G were not entangled. Moreover, entanglement seems to be about what information you can derive from modes through measurement. It does not seem that it is a property of the mode itself, but more a property of a particular context of possible measurements.

My impression is that sticking to Leibniz's requirement for indivisibility is the right way forward. Trying to 'combine' modes as in William James's famous 'combination problem' does not look to be neither a necessary nor a legitimate way of trying to explain experience. As Feynman says, there is plenty of complexity to be had with a single mode. Moreover, it is now clear that modes of excitation are not confined to the constituents of notional atoms. Indivisible energy-bearing modes come in all sorts of other forms, including acoustic or elastic modes. And this makes it possible to overcome the worry that a single mode would not have enough energy. The seismic modes generated by an earthquake or the hydrodynamic mode of a tsunami indicate just how much energy can be packed into an indivisible mode. These are just as much indivisible dynamic modes as electron orbitals.

The puzzle remains how we find biological energy-bearing modes that might be subjects of human experience within brains. A number of people, including myself, have made suggestions but I do not want to go into too much detail here. Almost certainly, Leibniz's requirement for human souls being immortal will have to be dropped, but nobody is likely to be surprised by that. I will return to this issue in the context of Whitehead's concept of occasions of experience.

Leibniz's denial of interaction

Before considering any detail of an interpretation of monads in terms of modes it is useful to consider Leibniz's general view of causality. An apparent paradox in Leibniz's approach is that although he sees that physics is really all about causal relation rather than the 'existence of matter' he appears to deny any interaction, and that might seem like denying causal relation. His 'progression in harmony' can be parodied as a sort of 'pandemonium ex machina' with an infinite number of monadic entities dancing a sort of eternal magical minuet in which bodies never touch. Such a parody might well have appeared reasonable in the nineteenth century when to the ordinary man (and the philosopher uneducated in science) it seemed that a Newtonian billiard ball mechanical model had won the day (even if serious physicists like Maxwell were probably well aware that it was a shaky quick fix). However, modern physics looks about as close to progress in harmony as you can get. Nothing bumps into anything in modern physics. Each mode of excitation obeys rules determined partly by its own 'principles' like its charge or mass and partly by the field of potentials with which it 'progresses in harmony'. The modern view of causation is exactly like Leibniz's. It lays down rules for co-contingency of dynamic progression – if A,B,C and D are doing this then E will be doing that. No more can be said.

As I understand it Leibniz's *cause célèbre* in this context is trying to persuade people to abandon the idea that causation involves the passing around of 'accidents', as the scholastics called properties like speed. Leibniz could not see how when a moving billiard ball hit a stationary one, with the result that the first became stationary and the second moved off, that the first ball had 'given' some 'motion' to the second. Unfortunately, Leibniz failed to convince his contemporaries because this medieval view is retained in the idea of an object 'having kinetic energy' in Newtonian physics. It is only with special relativity that it has become clear that this is a cheat. Kinetic energy belongs to the relation between things, not to objects.

The denial that entities can interact in the sense of 'acquiring accidents', like speed, is the basis of Leibniz's famous statement that monads do not have windows or doors through which anything might enter or leave. Fundamentally, he is saying that if we are dealing with the history of x and making true statements about x we cannot suddenly allow x to be 'x + some speed'. Speed does not stick on to things like a fridge magnet. Newtonian physics pretends that it can. Quantum physics now provides a formalism in which the idea of speed cannot be accommodated as an add-on extra because there is no longer a 'particle trajectory'.

In order to produce the necessary shift in approach to causation Leibniz has to use language that may seem to overstep the mark. When the Newtonian model took hold, his protestations would have seemed fanciful. But he was just 300 years ahead of his time. Moreover, unfortunately, the reference to having no windows and doors has often been interpreted as meaning that the monad is somehow causally cut off from the universe. This is absolutely not Leibniz's intention. The monad reflects and perceives the whole universe and its history is in harmony with everything else – which is all that cause can really mean in physics without 'transferrable accidents'.

What did not help, however, is that Leibniz sometimes seems to use the wrong arguments. Perhaps the most striking case is paragraph 80 of Monadology, in which he criticizes Descartes.

Although Leibniz contributed an enormous amount in terms of general principles to science and logic he may have felt that his reputation in terms of specific contributions to physics was fragile. He seems to have been very proud of his contribution to the laws of conservation of momentum and energy, even if Huygens and others may have been at least as important. So he is keen to show that he had corrected Descartes's mistake of proposing a law of conservation of motion that did not take into account direction.

The upshot of this is that Leibniz claims that Descartes's idea of the soul interacting with the body by altering the motions of subtle fluids in the nerves by causing them to 'swerve' without loss of movement, is impossible. Leibniz claims that this would violate conservation of momentum because motion has to be conserved in

a particuar direction. What is intriguing is that this claim has led to an ingrained myth in philosophy of mind that interaction between mind and body ('interactionism') violates physics. It does not.

What Leibniz seems to have forgotten is that if the mind had equal and opposite effects on the motions of subtle, or not so subtle components of the body, with as much swerving to the left as swerving to the right then conservation of momentum would be satisfied. Moreover, by 1714 Leibniz should have been perfectly aware that this would be the default situation. Newton had stated that every reaction has an equal and opposite reaction. Leibniz's relativistic approach to space and time would imply that if a ball is allowed to fall to earth momentum is conserved because the earth is actually accelerating towards the ball, in inverse proportion to its mass, just as much as the ball is accelerating towards the earth. If a compass is laid on a ship's table and the needle swings to north the earth will have swung a little bit the other way.

Leibniz's final conclusion, that if Descartes had been thinking clearly enough he would have hit upon the theory of progression in harmony, is fair enough. But if the problem is being considered in terms of mechanical rules, which Leibniz claimed would also be satisfied, then Descartes's account is fine. What emerges from all this is just how new concepts of force and mass were at this time and how difficult it must have been to apply them consistently without the three centuries of textbooks that we benefit from now.

Leibniz could have argued that Descartes's soul, being immaterial, could not swerve the subtle fluids because it could not itself respond with momentum in the opposite direction. It would need to influence another piece of matter in the opposite way at the same time. This is precisely what happens with magnetic fields – they induce two material objects to move in opposite directions. The magnetic field is seen as 'belonging' to one object but it is not the matter itself. In fact electromagnetic fields fit very nicely into Leibniz's conception of active internal force. Moreover, Descartes does not stipulate that the soul has no inertia, or passive force, merely that it has no extension. So the argument at the beginning of this paragraph is not actually open to Leibniz to use.

I think there is a sense in which Descartes was a step ahead of Leibniz in recognizing that there might be entities that have active force but no passive force. In modern physics terms this corresponds to the massless bosons of electromagnetic fields and acoustic modes, in contrast to the mass-bearing fermions – quarks and electrons. Most neurobiologists would attribute the 'mental' to some sort of electromagnetic field perturbation rather than something with mass. We do not get lighter when we fall asleep. In this sense Descartes's 'two types of substance' has been confirmed. Where Descartes went wrong was to think of the primary character of the second type of substance as extension. Leibniz does better by showing that extension must be an aggregate phenomenon and that passive force, or inertia, is the primary characteristic of the second type of substance or mode.

God and reason

As indicated in the introduction I see Leibniz as assuming that the term God applies to whatever is the reason for everything. A modern scientific view might be that there is ultimately no such thing as a 'reason for everything' other than a concept in our own minds. On the other hand a lot of science, including basic theoretical physics, is still driven by an assumption of something like a reason why things are one way rather than another. In Leibniz's terms we might rephrase this reason as 'what is possible', indicating that there appear to be very reliable constraints on what events are possible in our world. Leibnniz actually talks of God as 'the Necessary Being' suggesting that beyond possibility there is even some sort of ultimate necessity, but it seems that this necessity comprises a range of possibilities, one of which is the acting out of the world we live in.

In these terms it might be said that Leibniz's God is fairly similar to Einstein's God. Einstein did not believe in a supernatural being but he did believe that there was some overall constraint on possibilities that might be called a reason for everything and he had strong opinions about what sort of a constraint that would be –

it would not 'play dice'. There are other aspects of Leibniz's discussion of God, particularly in relation to ethics, that go beyond this, but I will leave those aside for the present. What may be relevant here is that Einstein's view of God might also be equated with Spinoza's position and Leibniz is keen to indicate his differences from Spinoza.

Spinoza lumps the reason for everything together with everything itself and calls this Nature. He claims that what exists is what is the cause of itself (*causa sui*). This sounds like a cheat, but it is parsimonious and it might be the right way to dispose of a redundant intuition of 'reason for things'. It is also intriguing that it may be reflected in the dynamic structue of modes in field theory. Cause is seen in terms of process and process is expressed in terms of change or differentials in time and space. In interesting aspect of the modern mathematical definition of modes is that they are expressed in terms of their own differentials in time and space. Moreover, in the maths of complex harmonic oscillations differentials tend to take much the same form as what they are differentials of. In a sense a mode looks like a way of becoming itself. Nevertheless, I tend to side with Leibniz in thinking that the reason for something needs to be separated from the something itself.

Where I think Leibniz wins out is in the distinction between what is possible and what is actual. A reason will constrain what is possible, but that need not entail it being actual. And this implies an aspect of causality that I think is often overlooked. Reasons determine possibilities, which might be seen as *types* of dynamic mode or pattern. The type we call 'electron' would be an example. Causes give rise to *tokens* of dynamic mode or pattern. If God is the Necessary Being then he might be considered cause of himself since there is no gap between possibility and actuality for him. But for the constituent dynamic modes within the universe there is a sense that each is not just the necessary cause of itself; rather, each is a token actualization of some more general reason that specifies possible types. And at least in normal parlance the token cause of any mode would be the pattern of antecedent modes, not the mode itself.

The distinction between types and tokens has another implication. Token causes, being actualities, exist at a place and at a time. However, it makes no sense to consider 'reasons' in the sense of constraints on possibilities being at a place and time. The importance of this is that Leibniz's separation of God from the universe does not require that God 'be there before the universe' because God in this sense would not be at a place at a time. So although the atheist may prefer Spinoza's story of a world that requires no creator there beforehand to get things going, Leibniz does not require this either. And although the Spinozan scientist may be happy tinkering about with tokens causing tokens in the lab there seems to be no doubt that it is fruitful from time to time to ask what determines the possible types – what is the reason. Perhaps the bottom line is that Spinoza made no significant contribution to hard science, whereas Leibniz made major contributions, including identifying the 'reason' that we call the conservation of energy. And he did it by considering necessity and possibility, rather than just empirical correlation.

Complex relations between force and matter

Present day discussions of seventeenth century views of mind and matter often fail to take into account just how uncertain basic concepts like force and mass were at that time. There is a tendency to assume that anything decribed as 'spirit' would lie outside physics, but this was not the case. For Descartes, spirit was whatever gave rise to movement, and, clearly, something did. He considered matter to be totally inert and incapable of moving of its accord, so all movement had to be due to spirit, at least to start with, even if its continuation might involve transfer from one body to another through the laws of collision. In most of nature the source of movement would be God, simply because that was the name given to the source of things. For Descartes the exception was that individual units of spirit also existed in the form of human souls, which could determine movement of a body in their own right.

As Cottingham (1998) points out, although Descartes stipulates that only man has a soul of this sort, this does not necessarily mean that he did not think animals had feelings or perceptions. What was distinct about the spiritual unit that man possessed was that it generated its own *reasons* for actions. Descartes thought this was closely linked to the ability to use language. So spirit implied rational or law-like actions, either in the form of God acting according to what we would call the laws of physics or man acting according to decisions or rational thoughts.

In this, Descartes's account is very far removed from a modern scientific account but not in the sense of having a duality that science does not embrace. The duality of force and matter, or source of movement and that which moves has remained essential to physics until very recently. And Leibniz's version of the same duality is remarkably up to date. He proposes that *everything* is force or disposition (or as Heidegger translates it 'Drang' or 'drive' in English) and the dichotomy is between active force, which equates reasonably well to electromagnetic modes associated with charge, and passive force, which equates to the interaction with the Higgs field that we call mass.

What neither Descartes nor Leibniz could be expected to have any clue to is the fact that energy-bearing modes that interact with the Higgs field tend to have an exclusion rule, defined by Fermi statistics, that restricts the quanta of energy the mode can bear. The rule is best known for electron orbitals as the Pauli exclusion principle. Because multiple quanta of energy in these modes cannot fuse to form a single mode the modes have to arrange themselves as aggregates with particular spatial relations and it is this that underlies the property of *extension* or antitypy that Descartes thought was the hallmark of matter. As made clear in his letter of 1641 to Hyperaspistes[91] the crux of extension for Descartes (and also for Leibniz) is spatial *exclusion.* It turns out that extension is not 'excluding from space' in the way a billiard ball would, but 'excluding from a way of relating in space' in the form of a dynamic mode. Because ways of relating involve distances an aggregate of modes builds up a lattice of modes of relation that has a defined size. (Note that in quantum theory there is no billiard ball exclusion. An electron orbital includes a finite probability of the electron being 'found' inside the nucleus, in the same place as the protons and neutrons. There is nothing to say that a pair of electrons cannot be 'found' at the same place in an s orbital, merely that they must have opposite spin, wherever they are found.

Leibniz appears to understand the need for this non-billiard ball type explanation for extension. He never tries to formulate a mathematical model for monadic dynamics, but considering the complexity of what we now know and the technology required to show it, Leibniz can hardly be blamed for this. But if he had a rough idea it may have not been too far off the mark. With the widespread skepticism about Democritan atoms in the seventeenth century perhaps the most popular idea for the nature of matter, which Leibniz used early on and continued into the nineteenth century, was that it consisted of 'vortices'. That might sound fanciful, but it is much closer to orbitals than billiard balls.

Another general aspect of Leibniz's approach that may be worth taking seriously is that dynamic units are effectively ways the universe can reflect itself in a point of view. Put another way, instead of the Aristotelian idea of objects with properties, Leibniz is suggesting that a monad is one of an infinite number of internal relational properties of the universe. This comes very close to the 'top-down' aspect of modern field theory in which dynamic units are seen as 'excitations' or perhaps 'ripples' in a universal field. The universe is not seen as built up from particles, but rather individual dynamic modes are seen as 'divisions' or asymmetries of the universe. As Leibniz suggests, the simplest universe is not one atom in empty space. It is a homogeneity within which no individuals can be distinguished. As Saunders (2003) points out, Leibniz's concept of identity being linked to discernibility or distinguishability is relevant and applies rather well to modern

[91] The mind is co-extensive with the extended body even though it has itself no real extension in the sense of occupying a place and excluding other things from it.

ideas about identities of electrons and their dependence on discernibility.

An implication of this top-down view of physics is that our intuitive idea that all large scale phenomena are 'due to' the combined effects of vast numbers of small scale billiard ball phenomena may not be as legitimate as we assume. When we say that a wave on the ocean is not itself a dynamic unit but 'merely' the combined effect of masses of water molecules with kinetic energy we may be further from the truth than the medieval scholastics. We have become obsessed by the idea that everything is 'explained' by tiny little bits of matter dashing about, despite the fact that physics denies these exist. Leibniz sees that the scholastic concept of a 'substantial form' being as necessary to an object as the matter it is made of is not to be ridiculed, even if it needs major modification.

A simple example of where a top down approach is needed is the reflection of light off a sheet of glass. For a century we have been encouraged to think of all physical events as being decomposable into interctions between 'fundamental particles'. The relection of light is usually explained on the basis of photons interacting with electrons in the glass, perhaps being absorbed and re-emitted. However, considered in particle terms this will not explain reflection. Electrons are not 'flat' in any direction so a single electron would not be able to arrange reflection such that the angle of incidence equalled the angle of relection. The photon must interact with a surface – a form. For this to happen both the photon and the surface have to interact over a finite extent, not at a point. (As Feynman points out in a famous lecture, the photon has to interact with the other side of the glass too.) This interaction over an extent is quite unlike the mechanical interactions of levers in which different parts play different roles. The immediate interaction of photon with glass is indivisible.

In this context, Leibniz's perplexing monadic units begin to make a great deal of sense. Moreover, the idea of progression in harmony also makes sense because there is no mechanical 'bumping into' or, as Ladyman and Ross (2007) call it, 'microbanging' going on. The behaviour of the photon and the glass simply agree in a certain way.

A specific point that Arthur (2014) picks up is that Leibniz realizes that the relative nature of space implies that no element of matter can actually 'have some speed'. Speed cannot be an 'accident' that an object acquires and then gets rid of. Speed is a property of a relation within the universe between some A and some B. To get around this problem and provide an explanation for what movement involves Leibniz seems to latch on to what we would now call kinetic energy – mv^2 (the missing ½ is unimportant). Leibniz seems to want this to give an 'entelechy' or 'drive' to the body that explains its continued relative motion to other parts of the universe. The problem is, as I see it, that the v is just as relative here as in speed. Even kinetic energy has to be seen as an internal relational property of the universe rather than a property of an object. What Leibniz gets right is that in any interaction of a mechanical kind the total amount of mv^2 in the universe is conserved. He is also on the right track with modes having energy but this turns out to need a new maths.

My impression is that Leibniz, effectively working on his own, or perhaps in communication with a very small number of like-minded thinkers equally 300 years ahead of their time, simply does not have the resources to build a coherent fundamental dynamics out of all his insights. He gets some things nearly right but not enough to form a coherent theory. In some ways his late dynamics look like a bungled first attempt at quantum physics rather in the way that his ideas of the 1660s were a bungled attempt at what was to be Newtonian dynamics. But then if we stand back and look at the current state of condensed matter physics, with its mish-mash of classical and quantum field theory descriptions one is tempted to think that we are still making a muddled bungling attempt to define what will turn out to be the physics of fifty or a hundred years from now.

Application to specific modes

A particularly counterintuitive aspect of Leibniz's monadic dynamics is the idea that monads exist in a sort of hierarchy in which each monad has an aggregate of other monads that form a 'body' to which it can be associated. Leibniz says that this goes on to infinity. This sounds very unlike the modern view that there are a finite number of fundamental mode types in the universe, or at least in the observable universe, consisting of electrons, quarks etc. and that there is no further 'infinite divisibility'. (In fact there are recognized to be a much wider range of mode types.) I will deal with infinite divisibility in a later section but first would like to consider what the relation of a monad to a body could be in modern physics. As usual, it looks to me as if Leibniz has all the crucial ingredients in his model, and although his synthesis does not seem to quite fit the modern account, he may be right to a first approximation much more often than appears.

A silver atom may be a useful example. A silver atom is an aggregate that is constituted by quarks of various types, with their gluons, and a series of electron orbital modes including a single 'outermost' orbital giving the atom a valency of 1. This outer electron orbital mode only exists as the mode it is because of the existence of all the other nuclear and orbital modes combined. There is no such thing as an outer silver atom electron mode without the aggregate that is the rest of the atom. So it is not unreasonable to say that the rest of the atom forms the 'body' for the outer electron orbital mode.

An objection to this is, of course, that a similar argument applies to all the other modes involved, so there is no 'dominant monad' here. But does Leibniz say that there always is one dominating monad when it comes to 'bare monads' of this trivial sort? Perhaps the best one can say is that he is suitably vague. Moreover, there is at least a pragmatic sense in which the outer electron orbital is 'dominant'. The contribution the silver atom makes to observable phenomena is almost entirely determined by the dynamic dispositions of this outer electron, at least in terms of chemistry. The quarks contribute inertia but that seems consistent with Leibniz's approach. The dominant monad is the one that calls the tune in terms of active force. Passive force comes along with the body. The fit is not perfect but Leibniz is not so far out.

The next objection might be that if the silver atom becomes an ion by allowing its outer electron to part company and become a 'free electron' then what is the body for this free electron mode? Again, I think Leibniz has a lesson for us because 'free electron' is an idealized abstraction based on the false assumption that this is a mode that is not dependent on any particular pattern of potentials. The dependence on potentials may be very different from that of the electron in an orbital mode but it is still dependent on potentials. Immediately after the Big Bang there were no free electrons because the field of potentials did not permit such modes. The 'body' for a free electron may then be a very different sort of asymmetry in a pattern of potentials from that formed by an atom, but in the sense that no electron mode can exist without a relation to a field of potentials that determines the nature of the mode there is no qualitative difference. This is in keeping with Leibniz's claim that each monad reflects the entire universe but most particularly its body. In modern field theory a mode's existence reflects the possibilities offered by the entire universe in terms of the field of potentials, but most particularly a local pattern of potentials, such as that provided by a silver atom or even that of a vacuum in a cathode ray tube through which a 'free electron' might pass.

This argument may seem to stretch Leibniz's concept of monad relating to body to the limit but I rather doubt whether Leibniz himself would have been too concerned. I think he was well aware that the reality he was trying to pin down would be extremely abstract and counterintuitive in many respects.

Where Leibniz's model is most intriguing, as I see it, is in the proposal that macroscopic aggregates, at least those whose structure is ordered by the reasons we can call the laws of nature, or God, are associated with an indivisible dynamic mode that is global to the aggregate (at least those not merely put together by the clumsy hand of man). This is where Leibniz wants to reintroduce a version of the scholastic substantial form to an entire 'object' or at least a 'body'. Application of quantum field theory to condensed matter turns out to predict modes very much of this

sort. As indicated already, a wave on the ocean is a quantized mode because it has energy content and all energy is quantized. The ring of a bell is a mode that exists because of the way the ordered structure of the bell forms an asymmetry in the universe (even if assisted in casting by man). Everyday objects are perhaps most easily proven to be 'objects' by the fact that they can spin around without flying apart. Spinning around is a rotational mode with energy content.

Analysis of macroscopic modes of this sort becomes extremely complex but there is no doubt that ordered structures do behave in a way that is dominated by certain global indivisible dynamic modes. These are Bose modes that are sometimes referred to as 'quasiparticles' as if they have a slightly dubious ontology. Since they contain energy not explained by any other dynamics their ontology is robust. What is true is that their measurable behaviour appears even more distant from the intuitive idea of a particle than for electrons or quarks, partly because the quanta of energy fuse to form modes of any multiple of the basic unit you like and the individual quanta probably do not have any meaningful independent existence. Phononic modes are perhaps the most relevant here, since the other key feature of a coherent object is that it supports acoustic modes like the bell's ring or the chink of a pot that is not craked.

There has been a debate amongst Leibniz scholars about whether Leibniz continues to recognize the existence of 'bodies' in his mature monadic philosophy. Garber suggests that by the time of Monadology Leibniz has come to see monads as the only existents, with bodies, being matter, being simply the phenomena that arise from aggregates of monads. Others suggest that Leibniz retains the idea that bodies are more than just aggregates; they have some additional reality as entities, even if they are not strictly independent substances on their own.

Modern field theory provides a rather intriguing justification for the latter view. Global Bose modes are not associated with aggregates in all cases. A pile of stones would not have any global modes in the way that a bell does. Field theory indicates that such modes only come into existence in association with patterns of order that instantiate specific types of spatial asymmetry in the universe. A 'body' of the sort that has a mode that could be its dominant monad is not something arbitrarily defined by a commentator. It is real in the sense of instantiating a real asymmetry, and in field theory asymmetries are perhaps the realest things there are.

Another way of looking at this, which fits with Leibniz's account, is that a body is the domain of operation of a mode that is a point of view on the universe. It is necessary, in order for there to be such a point of view. So mode and body, in this case have an intimate co-dependency of the sort that Leibniz probably did want to hang on to, even if Garber is right to indicate that he clarified and focused on the fundamental role of monads in his later writing and came to reject any sense of a body existing other than in this subtle co-dependent sense.

Living monads

Where the relation to Leibniz's concept of monads looks more strained is in the context of iving organisms, which is important because Leibniz clearly sees the basic active force within monads as a sign of *life*. Nevertheless, there is a suggestion that Leibniz's conception is not as far away from modern physics as might seem.

Leibniz must have understood that the way to understand matter better was likely to lie in ways of observing it at smaller scale. The idea that the extension of matter arose from internal forces had come from macroscopic physics but Leibniz must have been particularly impressed by the recent invention of microscopes capable of demonstrating entities invisible to the naked eye and, in particular, the living cellular entities to be found in pond water. In Monadology he uses the example of these micro-organisms to justify his claim that there are active forces at smaller and smaller levels. It seems now that his extrapolation to infinity is misplaced but as I shall indicate in the next section there may be a paradoxical sense in which he is right.

In many ways a swimming protozoan would seem to present the ideal example of a body associated with a global dynamic mode. These creatures seem to manifest a form of 'drive' that involves the entire body in a single action. This drive turns out in many cases to be mediated by cyclical motions of cilia or flagellae and so may not be as global as appeared to Leibniz but these cyclical motions may well be in turn mediated by very basic dynamic modes grounded in the cytoskeleton and cell membrane. I think it highly likely that quantized energy bearing elastic modes are involved, even if they mediate a dissipative energy-losing process of locomotion.

The difficulty facing both Descartes and Leibniz in accounting for human souls was that there could be no such simple relation between an active or spirit mode and a whole human body. Descartes places the active unit in the pineal and wires it up to nerves. Leibniz is more non-committal. Both, in fact, want to claim that the soul in some sense functions predominantly where sensory information is available in the nervous system but that it also has a relation to the entire body, but not a mechanical one.

My guess is that, if pressed, Leibniz might have agreed that the human soul ought to have not just a more intimate association with the whole body but a particularly direct association with something in the brain very much like the swimming protozoan, some micro-body that could have a global mode of activity. The reason for suggesting this is that Leibniz hints in Monadology that human souls are able to reason and know eternal truths because, unlike most tiny spermatic animals, they have been fortunate enough to be incorporated into a fully developed multicellular body where they can benefit from clear perceptions provided by sense organs. Leibniz makes it clear that for him these monads will have been, before conception, and are destined to be, after bodily death, associated with microscopic bodies that will not provide them with clear perceptions allowing reason.

So there is at least a hint that Leibniz might have acceded to the idea that the human soul was to be found associated with what William James called a 'pontifical cell' somewhere in the brain. This is an idea that modern neuroscience rejects, but it is interesting to consider exactly why. The usual argument is that there is 'no single place where everything comes together', but it is not always clear just what this argument entails.

It is almost universal in philosophy to assume that an animal would have a single dynamic unit of a 'soul' type. So the search is on for a primary domain for it. Descartes suggests the pineal because he thinks it is the only unpaired part of the brain. For any other site you would have a soul on each side. His proposal has been rejected on two grounds. Firstly, the pineal seems to have few if any important functions in man. Secondly, there is the argument that there does not seem to be any one particular place where information comes together. It is generally believed that the dynamic events that are responsible for our experiences and decisions are widely distributed throughout the brain, especially the cerebral cortex. This has meant that in recent times few attempts have been made to attribute a specific locus to a dynamic unit of 'soul' type. The situation has been compounded by the fashionable, but inappropriate, view that Descartes's 'soul' was something outside physical dynamics. Descartes certainly thought it had unusual dynamics but not, I think, 'outside physics'.

The problem is that there is a danger of a non sequitur argument slipping in to the analysis. The fact that 'there is no single place where everything comes together' does not entail that 'there is no place where everything comes together'. It is just that if the coming together of a pattern of information that is to be experienced is occurring in various places distributed over the cortex it must mean that there are lots of places where 'everything' comes together, with 'everything' being whatever does come together in experience. Introspection is probably a poor guide to how much does come together at any one instant but if we think there is integration of patterns in experience at all then presumably we must assume this occurs in lots of places at the same time. Neurobiology certainly provides firm evidence for virtually all signals in the brain being received, via axonal branches, in lots of places at once.

Abandoning the idea that there is only a single locus of perception or experience in a brain is one of the hardest, most counter-intuitive steps to make. Yet neurobiology makes it a

default assumption. Our actions are to be expected to be determined by lots of perceiving and deciding units in our brains, acting in some form of consensus. This provides a way of making sense of Leibniz's concept of a soul monad, even if one with a stark change of premises. Just as it may be that no single orbital mode in a silver atom, and perhaps more obviously in a chlorine atom with seven outer orbital modes, can be considered the dominant monad for this atomic 'body' we may have to accept that there is no single dominant monad for a human being. Rather than denying the existence of any subject of experience, and rubbishing Descartes in the process, as is fashionable in neuroscience, perhaps we should accept that there are many subjects within a single brain.

So the resolution to the problem of where the soul monads are, suggested here, is that monads with human heightened perception or apperception are associated with certain types of nerve cell of which there may be thousands or millions, forming an 'audience' of listeners. Each would perceive and the combined dynamic effects of the resultant outputs would then represent what might be called human will.

Although I want to avoid discussing specifics of biophysical models for 'human souls' there is a passage from New Essays paraphrased by Arthur (2014) that might turn out to be remarkably prescient. "Leibniz asks us to imagine that inside the room (as metaphor for within the brain) there is also a screen or membrane onto which these images are cast, one that is 'not uniform but diversified by folds representing items of inner knowledge'. The membrane, being under tension, 'has a kind of elasticity or force of acting, and even an action or reaction adapted as much to past folds as to new one caused by the impressions of the images', its action consisting in an oscillation like that in a tensed cord vibrating in response to a musical sound." I have only recently encountered this passage but my own deductions about the biophysical mechanism of experience over the last ten years have led to me to an uncannily similar conception of a pattern of input potentials interfacing with a neuronal cell membrane, folded into the tubular manifold of the dendritic tree and supporting an acoustic vibration that, through resonance, reflecting both the current in put and plasticity of synaptic dynamics based on previous inputs, determines the cell's output. Where I would differ from Leibniz is in that he sees such an interface as being one of many within the brain with a global soul having perceptions of all of them.

Leibniz's infinite divisibility of matter

Leibniz maintains throughout his life that matter is infinitely divisible, as Descartes had. This might seem erroneous now, but it is important to be clear what is being claimed. When talking of matter Leibniz is, at least initially, talking of the phenomena we encounter as having size and shape and taking up a certain space – extended matter. We might say that this is not infinitely divisible because once we are down to a single electron we cannot divide further. The error, here is to regard an electron as 'matter'. An electron, as indicated above, has no extension or shape. It has no right hand side distant from a left hand side. If anything it is the modern version of the monad, and its body may be the aggregate atom it is associated with, or for a valency electron in a metal object, the whole object.

What Leibniz is wanting to say, I think, and reasonably so, is that wherever there is shape and size in the phenomenal sense it is divisible. If we still have some shape or size it must be divisible again.

This may not sound quite like infinite divisibility, considering matter in more abstract terms at levels that might not be perceivable, and it may be that Leibniz did envisage that there was an infinite hierarchy of smaller and smaller bodies, each with a dominant monad that would contribute to the next level up of aggregation. But the logical arguments he uses are not necessarily inapplicable to what we now understand.

Richard Arthur (2014) points out that infinity is a subtle concept for Leibniz, particularly in relation to infinite divisibility. For Leibniz infinite divisibility of matter does not seem to mean that there actually are an infinite number of infinitesimal parts to a

piece of matter. Parts of matter do not have any particular identity for Leibniz, only monads have that. What he wants to imply is that there are an infinite number of possible ways to divide a piece of matter. And those ways have to be actual dividings, i.e. operations of division, because without this there is no sense of lots of little bits in rows ready to be separated.

That might still seem wrong if we are thinking ordinary chemistry but if we think in terms of what goes on in the Large Hadron Collider at CERN it does rather look as if the ways you could smash up matter are pretty limitless. A wide variety of monadic dynamic units might result, including vast quantities of photons of almost any energy content you like, as in a hydrogen bomb explosion. And, as indicated above, there are a lot more modes of the quasiparticle type to consider in addition to the traditional subatomic ones and these have a much wider range of variation in their parameters.

What may be relevant here is that Leibniz is wanting to keep away from any conventional additive mereological view of matter. For him matter comes about through the combination of units of force. If these operate, say, a bit like vortices, then the combination is not going to look like any sort of addition. And although there is a level at which modern physics seems to allow for addition of atoms, there are lots of other aspects of the overall combination and ordering of modes that do not work like that. Leibniz could not know the details but he would have reasons to think the additive model was inadequate.

This interpretation of Leibniz's claims may seem fanciful, but it may be fair to say that Leibniz has hit on a basic principle that proves right, even if we consider matter in abstract terms rather than perceived phenomena. He is suggesting that the basic constituents of matter, which for him are passive and active forces, ought to be dividable up in an unlimited number of ways, as proves to be the case. On the other hand any particular actual division is amongst indivisible dynamic units, monads, or in modern terminology, quanta. Moreover, although the Higgs field does appear to be able to throw up quantized modes (or 'particles') the interaction with the field that is the basis of mass, or passive force, which is perhaps the cardinal aspect of 'matter' in this context, follows continuous rules such that there is no grain or limit to how much mass a mode can 'draw' from the Higgs field. It is an infinitely continuous resource. As Arthur points out, Leibniz thinks of infinitely divisible matter very much like infinitely divisible space. To divide it is to 'use it a different way' rather than to separate parts.

Temporal problems with monads and relativity

In general, what seems most anachronistic in Leibniz's account in relation to modern physics is the fact that although he wants to make the world purely dynamic he retains an idea of enduring substance that does not fit well with the relative aspects of both special relativity itself and of quantum theory. A dynamic unit that is defined irrespective of time but not space does not fit well into a physics with a single metric of spacetime. This is where Whitehead noted a deficiency and moved to the idea of the dynamic unit being a brief occasion – whose contribution to the universe is indivisible in time as well as space.

In a simple reading, all Leibniz's monads would appear to be immortal and this might seem to be inconsistent with modern physics. The suggestion is that Leibniz made the error of thinking that the number and identity of units of energy was conserved, as well as the total amount of energy. The account in the Monadology is not quite that simple, however. Leibniz indicates that a monad can only be created or annihilated, not 'assembled' or 'disassembled'. Although creation might be taken to occur at the beginning of time, this does not seem to be what Leibniz is intending because he says that through constant fulgurations monads may be brought into existence – presumably at any time. If a fulguration is the join in a Feynman diagram then we do not seem to have any problem. Modes either are in operation or are not. They appear and are annihilated.

Where Leibniz does appear to want to be specific is in the context of human souls. It is pretty clear that these have been around since

the beginning of time, attached to some microscopic body or other that at some point has the good fortune to be incorporated into a full human being. This view was presumably founded on religious conviction, or at least a desire to propose something consistent with religious dogma. It is doubtful that even devout Christians would want to follow it today.

Nevertheless, there is an abstract sense in which one could just about allow Leibniz the immortality of all his monads in the context of modern field theory. A mode of excitation as now defined does in theory have values for all places and all times in the universe. Most of these are considered 'trivial' in the sense that the probability of 'finding' the mode at certain times or places is in practical terms infinitesimal. I do not think, however, that this point really helps with the absurdity of the claims for human souls hiding away in microscopic bodies for fifteen billion years before conception. What I think it may serve well to remind us is how Leibniz's logical principles often turn out to be correct in a technical sense even where they seem absurd and that it is usually the application rather than the principle that needs updating.

In Specimen Dynamicum (1695) Leibniz makes a distinction between the enduring forces that are the internal principles of the monad and more temporary aspects of dynamics ('vis activa derivativa') that govern short-term interactions. He thus recognizes something a bit more like an occasion. This raises the possibility that Leibniz is right to consider enduring modes as a background to 'occasional modes' (one might consider electrons as enduring and orbitals as temporary, although there are reasons not to give electrons 'quiddity' in modern physics). However, there are a large number of situations in which it seems that we have to consider modes as being temporary phenomena that do suggest that Whitehead was right to extend the dynamist view so that units were indivisible in time as well as space.

In his critique of Leibniz's philosophy Russell raises objections to Leibniz's account of monadic perception in this context, but it is quite hard to find out exactly what Russell's objection amounts to. The chief difficulty as I see it is Leibniz's suggestion that the monads perception can be divided up into a series of events, and maybe even a finer grain of 'petits perceptions' that are subliminal. This raises the difficulty that if the dynamic relation of the monad to the universe is its perception and that perception can be divided in time it is not an indivisible relation, so the onad is not an indivisible dynamic unit.

The underlying problem seems to be that Leibniz sees space as a way of describing a sequence of adjacent coexistence but time as a sequence of successive, mutually exclusive existence. Russell quotes Leibniz as calling motion a continual transcreation at one point. What is now *is not* in the past or future. This gives a sort of discontinuity to positions in time that does not seem to apply to space. In a spacetime metric this distinction would appear to be lost.

But is this a real problem for Leibniz, or a misunderstanding of what he means? Modern physics seems to indicate that Leibniz has not got things quite right. He has a brilliant insight into the implications of dynamic indivisibility, but he wants to hitch this to an enduring entity of a sort that probably turns out to be a misconception. In tems of quantum physics the fact that perception seems to result in a series of determinate measurable behavioural outputs along the way throughout life suggests that we are not dealing with dynamic indivisibility. We can separate the dynamic relations of today from those of last week. On the other hand when dealing with genuine dynamic indivisibles like quantized modes or, in Bohr's terminology 'quantum systems' there is no such series of determinate outputs along the way – if there are we have divided things into a series of separate quantum systems.

There is, nevertheless, a peculiar inconsistency here if one considers acoustic modes. A bell supports an acoustic mode even when, in the ground state, it is not ringing. This might sound somewhat notional, but it is dangerous to dismiss odd aspects of quantum field theory as notional. When a bell is struck repeatedly for many minutes as in the call to mass on Xmas Eve we have a determinate series of outputs from the mode yet the mode continues to exist throughout, in some sense. This reflects the fact that Bose modes of this sort can contain any number of quanta of

energy and that energy can be gained and lost without collapse of the mode.

This might get around the temporal indivisibility problem but there is a further puzzle to deal with. If an experience or perception is based on a relation to a field of potentials in a domain of space and time we have to allow both the space and the time to be finite. Quantum theory does not allow us to build models around relations at a point in time or a point in space. If we want a sequence of experiences we have to find some way of 'punctuating' finite time periods so that we have a sequence rather than one very long experience. It is far from clear to me how this can be done unless we allow the mode to collapse and reform repeatedly.

These considerations might seem to be highly speculative but what I think Leibniz's approach points out is that without considering these sorts of dilemma it can be argued that neuroscience does not begin to have a cogent theory of how experiences arise – that is to say what discrete events they relate to.

Correspondence and progression in harmony

Leibniz's concept of progression in pre-established harmony is fundamental to his monadic dynamics. However, it appears in the Monadology in two slightly different forms. In discussion of individual monads Leibniz makes it clear that each monad progresses in harmony with the universe it reflects. That would appear to entail that each monad progresses in harmony with each other monad but there is a caveat here. It is not clear that a monad has any real relation to any one other individual monad. There is an implication that it only has one indivisible relation to 'everything else' as a totality. This is consistent with the formulation of modern physics where a mode has a relation to a field of potentials rather than to other individual modes.

The second form of progress in harmony comes in paragraph 77, where Leibniz is discussing the relationship between monad and body. This is the form of harmony that has rather inappropriately led to the idea of 'psychophysical parallelism' and the idea that Leibniz conceives of two separate ontological levels, on mind and body, which follow each other without interaction.

Although it hard to discern from Leibniz's writings I think a more useful interpretation is that Leibniz is talking of different levels of description rather than levels of existence. What I think he is saying is that if we consider monads individually all we will find is a final, or telic cause, harmonizing with a universe. However, if we consider matter in terms of aggregates that form bodies then we will find an account in terms of efficient cause. The distinction between telic and efficient causes arises for fundamental logical reasons to do with the distinction between an indivisible and a collection of indivisibles and how they can be described with propositions. An aggregate cannot have a beginning or end because it will involve a collection of different beginnings and ends, so a telic description cannot apply. What Leibniz tries to explain in paragraph 81 is that because everything is harmonizing at the monadic/universe level the telic description of a monad will always appear to harmonise with the efficient description of its body in such a way that it appears that the two are following independent laws and yet it also seems that they are influencing each other.

This at first looks all very confusing and suspiciously like a fudge. Yet it comes remarkably close to what in physics is now called the correspondence principle. This principle states that however counterintuitive and unfamiliar individual dynamic predictions at the quantum level may be, if they are applied to aggregate situations they will always turn out to agree with more traditional mechanical accounts, as typified by Newtonian mechanics. In fact agreements across levels of description litter the traditional accounts of dynamics too. Newton found that he could assume that the gravitational force due to all the different parts of the earth could be treated as acting at the earth's centre. Traditional wave mechanics assumes that the motions of parts of a solid or fluid can be treated in terms of general sinusoidal patterns. Statistical thermodynamics assumes that individual motions of components of matter can be treated as obeying statistical laws without knowing anything about individual components.

Whether Leibniz realized it or not he appears to have formulated a valid genral rule about the agreement between descriptions of the dynamics of individuals and those of aggregates. There is no strange 'psychophysical parallelism' involved, just the necessary pragmatics of dynamic descriptions.

Where it may be reasonable to consider this something of a fudge is that aggregate level dynamics of the sort Newton described are by and large derived empirically. They are what are found rather than what there is reason to find. So agreement with underlying reasons would simply seem to be a matter of people being careful about their observations. And over time the reality is that these laws have needed adjustment as more accurate measurements are made. Thus they are not 'extra reasons' that imply overdetermination.

What may be of greater interest is that both Leibniz and modern physics indicate that a body that is associated with an indivisible dynamic unit or monad may not be simply an arbitrary aggregate. Both for Leibniz and for field theory a pile of stones is quite different from something like a cell, or perhaps an ice crystal. Bodies 'inhabited' by global monads have an order or 'perfection' that is neither arbitrary nor imposed by an 'eye of a beholder'. For Leibniz this was a certain sort of order or perfection that was the hallmark of God's handiwork rather than that of man – perhaps one could say a natural order. For field theory the order has to be in terms of some form of breakage of symmetry that allows new dynamic modes to arise.

In this context there is a very interesting sense in which field theory shows that the behaviour of a body and a global dynamic mode inhabbitting the body co-entail each other in a way that one might call co-supervenience. A crystal of a certain shape will be associated with global modes that determine the growth of the crystal in that shape – which is why ice crystals, despite often being fantastically complex, tend to be perfectly symmetrical. This is a long way from what Leibniz would have had in mind but it may show just how deep his insight was when he suggested that individual telic dynamics will always harmonise with efficient aggregate dynamics.

Panexperientialism and perception

Leibniz's approach probably remained unfashionable during the twentieth century largely because people thought that he was postulating some peculiar 'mental' entities that explained an illusion of a 'physical' world. The popular 'materialist' view in which physics explains everything had no time for such things. However, this is merely a reflection of the naivety of popular materialism. The irony of materialism is that if it does indeed explain everything mental then physical things must be mental after all – or at least some of them. The bottom line is that Descartes and Leibniz had sorted things out in their minds rather better than most modern day scientists.

What probably underlies the skepticism of scientists is the assumption that only nervous systems, and certainly not rocks, will support 'perceptions' or 'experiences'. Ironically this is the fag end of a religious belief rather than anything to do with science. It is also based on intuitions we probably get from our mirror neurons and associated apparatus that need at least examining if not rejecting.

What Leibniz suggests is that, at least in operational terms, because at this stage he does not claim anything more specific, the way a monad relates to the universe via some active internal principle or appetition, is nothing more than what we call perception. He is saying no more than that what we call perception is the influence of the universe on an entity with a point of view. Influence is in the subtle sense of providing information about the state of things with which the entity will harmonise, just as in modern physics. So Leibniz is doing the job of the reductionist materialist for him (since the materialist cannot get around to it). He is saying that physics covers everything because perception is just being influenced by surroundings. Nothing could really be more inoccuous and elegant.

Leibniz's claims for the perceptions of more lowly or 'bare' monads, that might perhaps lie deep within a marble tile, are although they involve a relation to the entire universe they are 'confused'. Arthur (2014) makes the point that this can be interpreted in the etymological sense of 'fused together' or not

distinguished. This seems fair enough in terms of the way a mode relates to the universal field of potentials in modern physics. For many modes, such as electron orbitals, a fair approximation to what it would 'perceive' would be a simple pattern of potential, reducible to the nearby positive charge of a nucleus, to which it would relate in a sufficiently simple way to be allocatable a 'time independent Schrodinger equation". That is to say it will settle into a trivial pattern of complex harmonic oscillation. In contrast, the exchangeable electron in a complex iron/haem complex molecule might relate to a much more complex pattern of potentials. And an x-ray photon passing through a crystal of haemglobin protein molecules on its way to a screen might be expected to have a very complicated story to tell of its life history.

Leibniz does not enter into discussion of 'phenomenality' or 'subjectivity' in the way that is fashionable nowadays. There is very much an implication that for both him and Descartes that the mental/physical dichotomy that is now so derided would for them seem to be a straw man. Their dichotomy was between source of motion, or spirit, and that which could be persuaded to move, or matter. The fact that these two were intimately related was not in doubt. Nevertheless, it is probably reasonable to assume that even the confused perceptions of bare monads would be assigned 'phenomenality' or subjectivity in some very primitive sense by Leibniz. That is to say that these perceptions would fall into the same category as ours in the broadest sense, if without some important features like clarity and reflexivity.

This places Leibniz amongst what are called panpsychists, or perhaps less ambiguously, panexperientialists. Panexperientialism seems to have gone through a period of very low estimation in the twentieth century with the quip '…leads us to panpsychism , or worse…' being considered an acceptable way to block any further discussion. This seems to be shifting, however, with Skrbina's *Panpsychism in the West* (2007) and interest from other quarters including David Ray Griffin. This seems a laudable shift since, as indicated above, panexeprientialism in the sort of form Leibniz suggests does the work of reductionism better than reductionism and the objection to panpsychism seems to be justified largely by narrow religious dogma.

As indicated previously, a panexperientialist approach does not in any way indicate that everything is 'purely mental' or indeed a form of idealism. Most Leibniz scholars now appear to reject a traditional idealist reading of him and point out that he was very much a believer in a 'real outside world'. He does not 'reduce' the dynamic to the mental but rather points out that physics and perception are two ways of describing the same dynamic relations. Leibniz makes it clear that he does not consider 'ideas' or 'notions' to be real in themselves when he describes non-dynamic relations like 'is taller than' as mere ideas entertained by minds. Leibniz frequently talks of the monad or substance as having a 'complete notion' that includes all the true propositions that can be attributed to it. However, it does not seem that he confers the sort of 'third realm' ontology on propositions that Frege semed to. The implication is that there is some complete actuality that is the entire life of the monad that could ideally be conceived under some infinitely complex notion or narrative. The soul is not just an 'idea' in the way that the mind was merely the 'idea' of the body for Spinoza.

Knowledge

An important part of Leibniz's view on perception is that it provides room for very different levels, ranging from bare confusion to the very different phenomena of self-perception and knowledge of truths. If people want to quibble about differences between our perception and that of units of force within tiles then Leibniz offers appropriate distinctions. All that perception requires is some sort of dynamic relation. Leibniz is quite clear that self-perception and knowledge of truth are going to require very specific relations. In this sense one can also reasonably say that Leibniz is not offering panpsychism if 'psyche' entails these more complex relations.

It is not clear to me how complex or worked out Leibniz's view of the process of knowledge was. He talks of sense organs combining incoming signals to furnish the soul with heightened perceptions. Like Whitehead, it is clear that he sees the special sorts of perception human souls achieve as being at least in part due to being furnished with a sophisticated 'input-feed apparatus'. What he does not talk of is knowledge in terms of inference of distant dynamic events from the comparison of proximal signals under different conditions – which is basically how sensory pathways work.

When Leibniz talks of some spermatic animals, or cells, being fortunate enough to be raised to the level of a fully developed animal or man, it might seem that all that is needed to explain rationality is being supplied by a 'bolt-on' input-feed apparatus provided by a body of sister cells. However, again as Whitehead suggests, it also seems possible that the 'internal principle' or entelechy of a rational soul monad has some new form of complexity without parts that allows it to have knowledge.

For Leibniz it seems pretty clear that he sees the relevant complexity lying within the monad itself. He would like to think of a rational monad as a bit like a 'living automatom' passing through what we would now call computational states, very much along the lines of the subject of a Turing Test. If anything, it is Descartes who more explicitly suggests that some of the 'number –crunching' aspects of thinking might be hived off to other nerves. Nevertheless, Descartes also implies that the soul itself has some peculiar analytical power that relates to language and truth.

I am not suggesting here that we should expect either Descartes or Leibniz to have constructed a model for the dynamics of knowledge, or proof of truth, in actual dynamic terms in the way that Turing did. However, the issue of what sort of dynamic unit could 'know' remains very relevant to contemporary neuroscience. We have almost no notion of how truth is inferred within a brain, despite knowing a lot oabout nerve cell dynamics. In recent years it has become clear that brains do not work like Turing's machines, even if they can achieve the same results. So looking for a unit within a computer that can infer truth may not be that much help.

All that said, Leibniz's concept of truth might just provide a clue that has been ignored. Leibniz says that a truth is a proposition in which the predicate is entailed within the subject. It is essentially a comparison, or perhaps something a bit like the two pans of a set of weighing scales with a whole in one pan and the equivalent constituent parts in the other, such that, for instance

$2 + 5 = 7$

is true. Perhaps what Leibniz is telling us is that what makes a rational human soul with 'consciousness' in the more sophisticated sense of the term is some internal dynamic principle that not only relates to the universe but has an ability to compare features of its perceptions and judge truths. In a computer this all takes place piecemeal with signals being shuffled from one dynamic unit to another. However, the ways information is integrated and compared within brains may be quite different, particularly if it is grounded directly in the dynamic properties of modes within matter rather than in an arbitrary implementation of a mechanical routine between discrete material objects.

Leibniz places knowledge and rationality very highly in his level of values and derives what might be called a 'knowing-anthropic' principle that he uses to help explain the nature of our 'perfect' world. The anthropic principle states that we need not be surprised if our world seems rather arbitrary in some of its features. It may be necessary for the features to be that way in order for life to survive and experience anything. Leibniz goes further by suggesting that our world must include the possibility of knowledge because without that knowledge we could not know any truths about that world, which we do. Whether this principle does useful work is less clear, but it is hard to argue against.

Problems with telicity

Leibniz's distinction between the telic nature of causation for dynamic indivisibles and the 'efficient' nature of causes for aggregates is linked in the later premises of the Monadology to our

sense of 'purpose' and broader issues of ethics. A link between basic dynamics in physics with the sense of purpose might seem tendentious, but presumably the sense of purpose does relate to basic dynamics in some way, if we are to avoid 'magic ingredients'. The question is whether Leibniz is making the link in a legitimate way or whether it is an oversimplification.

Leibniz's idea that telicity could be found in basic physics is best illustrated by his observation that the most convincing account of the path taken by a ray of light is a telic one. The laws of reflection are most easily accounted for if we say that light always takes the shortest route between two points (this is grossly oversimplified, but it will serve the purpose here). This sort of 'explanation' is counterintuitive in that it more or less says 'assuming that this ray of light got from A to B, how would it have done it?' The explanation is odd because it assumes the end explains the means to the end. The fact that this works, as does the law of least action for trajectories of projectiles etc., may seem just a quirk of mathematics. However, in quantum theory, Feynman's analysis of light paths, and perhaps most specifically the results of the Aspect experiments testing for Bell's inequalities, suggest that for an individisible dynamic unit like a photon, or pair of entangled photons, the end of the dynamic unit is a necessary part of the entire dynamic 'mode of connection'. The mode does not even appear to come into being without the nature of the end being defined. There is no trajectory 'wending its way' towards an end, that might turn out to be deflected to some other end. There is simply an indivisible connection from beginning to end.

In this context, Leibniz appears to have divined a fundamental aspect of the nature of indivisible dynamic connections purely from logic. If we break the universe down into indivisible components, given that there are reasons to think there are such dicrete components, then you cannot have the beginning half of the component without the end half. The logic is powerfully simple. In Leibniz's terms 'everything that will ever happen to the monad' is implicit within it from the point of creation. Indivisible dynamic units have to follow a telic description because their end is an essential part of them.

This may be a remarkable insight, but there are suggestions that Leibniz does not himself see the necessity that is implied. In Monadology he suggests that the monad strives to each its end but that it may not necessarily achieve this in its entirely, all that can be said is that it will achieve it to some degree. Now this is a very different matter from the situation with the light path analysis. Here the 'end' is something to which the dynamic unit is somehow disposed to tend towards, but it is not necessarily entailed in the dynamic connection that results. The monad 'strives' towards something in some sense other than that it 'gets to where it is going to'. This is a very different meaning of end. It is the sort of end we associate with human purpose. This is a different use of the word 'telic'.

This might suggest that Leibniz's analogy of the light path is being put to the wrong use. However, there are signs that Leibniz is not blind to this dichotomy, at least not completely. He suggests that the achievement of an end for a bare monad is rather different from that for a rational soul. The tendency towards the end for simpler dynamic units has a sort of automatic aspect to it, as if blindly following natural laws. That sounds rather like the light path. The achievement of an end for a rational being, however, involves a knowledge of what is desired, even in situations where the desire is never fulfilled. This is an end of a very different sort. On a sense it is a possible type of end rather than an actual token end. There look to be profound problems here.

Leibniz does not resolve this problem satisfactorily but there might be a way of making more sense of it in terms of modern neuropsychology. Perhaps all indivisible dynamic units within our brains do reach the end entailed in their mode of action but because of the finite and imperfect nature of the way such units perceive the universe in terms of consequences for the body there is no guarantee that the 'desired end' for the indivisble unit will match to a 'desired end' conceived in terms of advantages for the aggregate body. Such an anlysis probably takes us away from Leibniz's attempt to link fundamental dynamics to some form of a priori ethics but it does at least fit in with his suggestion that the perfections of our world and the way they appear to us do not

always coincide. In other words although we have a sense of good we may not always see how that relates to a more universal conception of good or perfection.

Interestingly, when it comes to the universe, one might argue that the telic description applies in a way rather similar to that for the indivisible dynamic unit, but not for an aggregate. Cosmological laws seem to entail a necessary outcome in a way that laws for local events do not. Although it is still a matter for debate it is generally thought that the universe will either continue expanding to infinity or at some point collapse back on itself to form a 'Big Crunch' (or some variation on these themes).

Tension between monadic and 'embodied' or 'systems' views

One of the themes that seems to emerge from Leibniz's account is the idea that the behaviour of an entire organism, such as a human, can be attributed, at least in terms of more strategic aspects, with an indivisible dynamic unit that is somehow fused with the entirely of the organismic body. This is quite close to Descartes's view of the soul being in control of the body rather like a captain steering a ship. At times Leibiz clearly wants to avoid any sense that the soul is somehow invisibly moving the arms and legs around in some non-local or non-mechanical way. He says that the motions of the limbs have to be considered in strict mechanical terms since these are aggregate bodily structures. But Leibniz also appears to want some sort of global dynamic connection between soul and entire body. He also wants the soul to be the seat of memory, which seems to raise further problems with divisibility in time of dynaic relations. He wants the soul to be a continuing identity very different from the situation envisaged by Locke in which continuing personal identity was simply a byproduct of availability of the same off-line memory store.

This model of equating a soul with the 'drive' and perceptions of an entire organism is close to what is popularly termed an 'embodied' view in contemporary philosophy. The suggestion is that somehow subjectivity and behaviour relate in a non-local way to the entire 'system' or organism through a global functional relation that is often considered in a teleological way. Goal achieving and survival are often invoked in an evolutionary context, as in Millikan's teleosemantics or Varela's view of a self-sustaining or autopoietic unit.

I think Leibniz probably would have felt comfortable with this sort of approach but in my own view it does not sit well with the logical implications of his basic principles in the end. The body is divisible, not just in intuitive material terms but in dynamic terms, as he admits. I think if Leibniz had attempted to be more specific about the soul's dynamics he would have been forced to paint a picture much closer to that of Descartes, who admits that the soul, at least to a large extent, can be seen as operating locally at one particular locus within the brain. Descartes's soul perceives what it does because signals coming into a specific (pineal) site determine in a necessary and sufficient way, exactly what the content of perceptions will be. Descartes's soul is a 'brain in a vat' entity that would experience what it does without any body, as long as it was informed in the right way – locally. I think Leibniz probably realized that he would also need an account in which this was so, but he prefers not to address issues of locality.

And despite the popularity of the embodied approach amongst philosophers, neuroscience does not provide support for a non-local 'embodied' view of perception, at least not in a way that would suggest different predictions from a local 'brain in a vat' view. Evolutionary and embodied arguments are useful for explaining how it is that there come to be human beings on earth that perceive certain aspects of the outside dynamic world with salient features relevant to survival. What they are not useful for is describing how the organism that has evolved actually operates in internal dynamic terms. Functional requirements always leave plenty of room for different ways of instantiating those requirements dynamically (multiple realisability) and moreover, evolutionary pressures always relate to an environment that existed in the past rather than the one that pertains now, so the

evolutionary functional analysis never quite applies to reality – it is always one step out.

An irony of the contemporary view of biology is that although Wallace and Darwin effectively made teleology redundant in their accout of evolution, evolutionary arguments are increasingly being used in a teleological fashion. Why is everyone rowing back to a position shown to be unparsimonious? The intriguing thing about Leibniz's Monadology is that it provides a legitimate basis for true telicity within indivisible dynamic units. If the end is indivisibly entailed in the whole then the whole has to be end-directed. The problem is, as indicated above, that this sort of telicity involving an actual token end is not the same as a 'purposeful' telicity involving a possible type of end. I think this confusion needs sorting out.

Detailed discussion of Leibniz's ethics probably takes us into deeper water than is worth entering. Voltaire's critique of the 'best of all possible worlds' is hard to repudiate entirely, even if Leibniz's abstract arguments do seem to have some logical coherence. Whether Leibniz's account is driven by genuine religious faith or the political agenda Russell accuses him of his ideas of perfection and goodness beg a lot of questions. On the other hand there is also an aspect to Leibniz's account that has a rather more Shakespearian feel, which makes a bit more sense. It seems that Leibniz is saying that the tragedy of the human condition is the tragedy of finitude – the necessary limitation, or imperfection, of being a single point of view in the face of the perfection of all possible points of view. It is not that our life has no meaning or that there are no token ends to which things are directed. It is just that being limited and finite these ends do not necessarily match up with possible types of end considered in in the context of aggregate systems, as if those systems were also telic, when that is a contradiction in terms because their nature is one of efficient causation. Perhaps the ultimate irony is that science is slipping into a teleology more romanticised than the plot of Romeo and Juliet.

Conclusion

Exploration of Leibniz's world view time and time again suggests that he had a way of thinking that pointed in the right direction, even if this did not become clear in his lifetime. As Arthur says in his summing up, the Leibnizian approach to physics has proved at least as fecund as that of Newton and arguably much more so. His ambition to encourage the articulation and development of the 'seeds of thought' has been amply fulfilled. What I would wish to add to that is that I think we will find that the lessons we can draw from Leibniz are far from being fully appreciated and capitalized on. We need to revisit the motivation for all of his claims and re-apply the basic principles that he has handed down to us to new questions that have arisen in the light of new empirical knowledge. I strongly suspect that these principles will turn out to work even better in the modern context than they did for Leibniz. Perhaps they work better for quantum field theory than they ever could for his conception of souls. Ultimately, the strength of Leibniz's ideas is that they probe *reasons*, rather than just providing empirical laws. The concept of a reason may cease to serve purpose at some point in the conduct of natural philosophy but my impression is that this point is still a long way off.

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