
A. Influence of Sennert on Boyle.

• Mid-1650s. Of Atomicall Philosophy.

  - "...each atom is itself a mixt, bearing the essential characteristics that brand the whole as a substance." (Newman, pg. 163.)
  - "Atom" refers to a substance that is incapable of decomposition into more primitive components (the "negative-empirical concept").
Repeats Sennert's reduction to the pristine state of the gold/silver alloy:

"[T]hus sylver being dissolv'd in Aqua fortis & that Menstruum so well filter'd that the dissolv'd silver & it will both passe thorough Cap paper all the invisible particles of ye Metall which are so small that they hinder not the Diaphaneity of the Menstruum are yet each of them true silver as appeares by precipitating them to the bottome (by a little resolv'd salt of Tartar) in the forme of a subtle powder which is easily reducible into the same numericall silver that was at first corroded & so in the mixture of Metalls there is an union per minima that is Atomes... instances of this Nature might be easily multiplyed if I judg'd them requisite."

But: Where Sennert's intent is to critique the scholastic theory of resolution to the four elements (or prime matter), Boyle's is simply to affirm atomism.

Further rhetorical argument for atoms:

"How unimaginably little must be the parts that make the haire upon the legs [of a mite]."
• 1661. *Sceptical Chymist.*
  
  o "... largely a reinterpretation rather than a rejection of Sennert's chymical atomism." (Newman, pg. 170.)

"Neither is it impossible that of these minute Particles divers of the smallest and neighbouring ones were here and there associated into minute Masses or Clusters, and did by their Coalitions constitute great store of such little primary Concretions or Masses, as were not easily dissipable into such Particles as compos'd them."

• New claim that *minima* or *prima naturalia* combine to form molecule-like aggregates of a semi-permanent nature. (Recall Geber.)
Three notions of mechanism:

1. **Structural reductionism.**
   - "...the idea that a given entity, or... 'body' can be explained in terms of its purely material parts, which in turn are characterized only by a short list of qualities capable of geometrical description, such as size, shape, position, arrangement, and perhaps motion..." (Newman, pg. 176.)

2. **Denial of action-at-a-distance.**
   - "...the transmission of motion from body to body or from part to part... a commitment to the idea that motion can only be transmitted by direct contact between bodies or parts of bodies as opposed to being induced by action at a distance." (Newman, pg. 176.)

3. **Rejection of final causes.**
   - An adherence to non-teleological explanations.

- **Newman:** Boyle was not wedded to *a priori* (Cartesian) claims about the ultimate nature of matter and motion.
  - Rather, he was an empiricist Baconian: experiments entail structural explanations alone suffice to account for natural phenomena.
Ingredients in Boyle's structural explanations:

○ *Prima naturalia* = the first or smallest particles that cannot be divided further.
○ *Prima mista* = the first compounded bodies.
○ "Catholic affections" = essential characteristics of *prima naturalia*: size, shape, motion.
○ "Mechanical affections" = size, shape, motion, and texture (collective property of compound bodies).

**Important point:** "The fact that Boyle does not attempt to reduce all phenomenal change to the level of the *prima naturalia* or initial particles does not mean that his chymical explanations are not mechanical, since the aggregate corpuscles are also endowed with mechanical affections having explanatory force." (Newman, pg. 179)

"...the mechanical philosophy... was only partially reductionistic. Instead of appealing to the size, shape, and motion of the uncompounded and initial particles, Boyle frequently based his mechanical explanations on the access, recess, or transposition of unchanging aggregate corpuscles with chymical properties." (Newman, pg. 189)
**Example:** Color experiment.

- White mercury sublimate (mecuric chloride) is dissolved in water to form colorless solution.
- Salt of tartar (potassium carbonate) is added to produce orange color.
- Oil of vitriol (sulfuric acid) is added to make orange color disappear.

"...and indeed of all the Experiments of Colours, I have yet met with, it seems to be the fittest to recommend the Doctrine propos'd in this Treatise, and to shew that we need not suppose, that all Colours must necessarily be Inherent Qualities, flowing form the Substantial Forms of the Bodies they are said to belong to, since by a bare Mechanical change of Texture in the Minute parts of Bodies, two Colours may in a moment be Generated quite *De novo*, and utterly Destroy'd."
Mechanism vs. machine:

- "it is clear that Boyle's use of the term 'mechanical philosophy' was meant primarily to relate to mechanisms or machines." (Newman, pg. 185)

That then, which I chiefly aime at, is to make it Probable to you by Experiments... that allmost all sorts of Qualities, most of which have been by the Schooles either left Unexplicated, or Generally referr'd, to I know not what Incomprehensible Substantiall Formes, may be produced Mechanically, I mean by such Corporeall Agents, as do not appear; either to Work otherwise, than by virtue of the Motion, Size, Figure, and Contrivance of their own Parts, (which Attributes I call the Mechanicall Affections of Matter, because to Them men willingly Referre the various Operations of Mechanical Engines) or to Produce the new Qualities exhibited by those bodies their Action changes, by any other way, then by changing the Texture, or Motion, or some other Mechanical Affection of the Body wrought upon."

- Machines and their parts as capable of easy visualization and comprehension.

  "It is therefore unnecessary to invoke the traditional Aristotelian 'primary qualities' of hot, cold, wet and dry to explain their operation, nor must one resort to the presence or absence of the Paracelsian *tria prima*, mercury, sulfur and salt." (Newman, pg. 187)
C. Experiment and The Mechanical Origin of Qualities

¬ Essential attributes = those qualities that necessarily follow the structure of a particular aggregate corpuscle.
¬ Extra-essential attributes = those qualities that can be imposed or deleted mechanically without altering a particular aggregate corpuscle.

• Extra-essential attributes can be induced, eliminated, and/or altered by mechanical means: thus they are mechanical.

"...there are three distinct sorts of Experiments (besides other proofs) that may be reasonably employ'd...when we treat of the Origine of Qualities. For some Instances may be brought to shew, that the propos'd Quality may be Mechanically introduc'd into a por-tion of matter, where it was not before. Other Instances there may be to shew, that by the same means the Quality may be notably varied as to degrees, or other not essential Attributes. And by some Instances also it may appear, that the Quality is Mechanically expell'd from, or abolish'd in, a portion of matter that was endow'd with it before."
"That Lead may without any additament, and only by various applications of the Fire, lose its colour, and acquire sometimes a gray, sometimes a yellowish, sometimes a red, sometimes an amethystine colour; and after having past through these, and perhaps divers others, again recover its leaden colour, and be made a bright body."

**Two prerequisites for such mechanical explanations:**

1. The agent of change must be mechanical (e.g., fire).
2. The insensible corpuscles persisting through the induction, variation, and/or removal of extra-essential qualities really do exist.

- Reductions to the pristine state underwrite (2).
- *And:* Also guarantee that no change has occurred in the corpuscles undergoing extra-essential modification by mechanical means.
D. Against Substantial Forms

- "As [Boyle] looked at it, if he could show that the qualities that we know either directly by sense or by their actions can be induced or destroyed mechanically, why should we make the further assumption that things are different at a lower level of composition?" (Newman, pg. 210)

Redintegration of niter
- Inject burning charcoal into molten saltpeter (potassium nitrate).
- Nitrogen and carbon are released in combination with oxygen, leaving a non-volative residue of "fixed niter" (potassium carbonate).
- Add spirit of niter (nitric acid) and reacquire original saltpeter.

- "Niter was a naturally occurring substance and ought *ex hypothesi* to have a substantial form. But it could be broken into two very distinct materials -- each with its own set of properties -- and then (in principle) reassembled just as one assembles the parts of a watch. The very arguments that told against the return of a form from its privation, which had worked in favor of Sennert's persistence of the substantial form, now worked against the idea that niter had a substantial form of its own." (Newman, pg. 212)
Reduction of camphor to the pristine state

- Dissolve colorless camphor in colorless oil of vitriol to produce a deep yellow-red solution.
- Add sufficient amount of water and reacquire colorless camphor.

"This Experiment may serve to countenance what we elsewhere argue against the Schools... For whereas though some of them dissent, yet most of them maintain, that the Elements alwaies loose their Forms in the mix'd Bodies they constitute; and though if they had dexterously propos'd their Opinion, and limited their Assertions to some cases, perhaps the Doctrine might be tolerated: yet since they are wont to propose it crudely and universally, I cannot but take notice, how little tis favour'd by this Experiment... And this Experiment being the easiest instance, I have devis'd of the preservation of a Body, when it seems to be destroy'd, and of the Recovery of a Body to its former Conditions; I desire it may be taken notice of, as an instance I shall after have Occasion to have recourse to, and to make use of."

- "In short, Sennert's *synkrisis* and *diakrisis*, the operations that were supposed to reveal the permanence of the substantial form, had now become the very tools of its destruction."  (Newman, pg. 214)