Examining the Language of Science in the Prose of William Harvey and the Poetry of Margaret Cavendish

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This interdisciplinary paper crosses a study of science with a study of literature. It will examine the language of science in a work of seventeenth century scientific prose and a piece of seventeenth century scientific poetry. This is done through a comparison between William Harvey's medical treatise on the circulatory system entitled 'On the Motion of the Heart and Blood in Animals' (1628) and Margaret Cavendish's poem on the same subject entitled 'The Motion of the Blood' (1653). Both textual artefacts will be explored within the wider context of the seventeenth century debate over the appropriate language style for science.

When it comes to the subject of the language of science, the customary opinion has been that language used in scientific writings should reflect the plain clarity of reason and the straightforward simplicity of science itself. This view can be traced back to the writings of Sir Francis Bacon whom many scholars consider to be the father of modern scientific prose because he advocated the use of plain prose as the appropriate style of language to be used in scientific writings.[1] This opinion would later be echoed amongst members of the scientific academy known as the Royal Society where men like Thomas Sprat rejected the 'amplifications, digressions, and swellings of style' in favour of plain prose language. [2] As a result of this preference, an irreconcilable rift has been created in science between prose and poetry. Prose was to become the accepted and recognised medium for science while poetry was to become its adverse opposite and an example of what scientific language should not be: descriptive, imaginative, evocative, and abstract in its subjectivity. The new science had to be impersonal in its objective pursuit of reality, reason, and knowledge.

Recent studies on Bacon, however, have renewed the old debate between poetry and prose in science. Critic Robert Schuler has examined Bacon's writings and argues that the great thinker himself could not ignore the important role poetry plays in science by inspiring the imagination and aiding reason.[3] Poetry and prose, reason and imagination are therefore not diametrically opposed to each other but support each other in the practice of science.[4] Another critic, Stephen Daniel, also sees Bacon acknowledging the positive role poetry plays in science because of how it can help foster the scientific method. As the method involves generating hypotheses that are later to be tested in experiments, it is crucial during the initial stage of formulation where questions are being asked and theories are being formed, that this

[1] James P. Zappen, 'Francis Bacon and the Rhetoric of Science', *College Composition and Communication*, 26.3 (October 1975), pp. 244-7, (p. 244) <http://www.jstor.org/stable/356123> [25 Jan. 2016].
[2] Zappen, 'Francis Bacon and the Rhetoric of Science', p. 244.
[3] Robert M. Schuler, 'Francis Bacon and Scientific Poetry', *Transactions of the American Philosophical Society*, 82.2 (1992), pp. 1-65 <http://www.jstor.org/stable/3231921> [25 Jan. 2016].
[4] Schuler, 'Francis Bacon and Scientific Poetry', p.19.

process of invention be inspired just as much by imagination as it is guided by reason. For Daniel, Bacon's description of nature as a language controlled by *grammatica philosophica* or 'philosophical grammar' entails that treating nature as a 'poetic and metaphoric language instead of as a logical, mathematical, or rationally regulated language' can help develop the 'procedure of discovery' [5] -- which is the aim of the scientific method. According to Daniel, having a concept of nature that is metaphorical / poetical means having a nature that cannot be easily grasped, which leaves any account of the world open and indeterminate.[6] Having a nature that eludes easy understanding forces scientists to continue inventing new approaches towards understanding it. In terms of the scientific method, this leads to new questions being asked, new hypotheses being imagined, new experiments being designed to test them, and new theories being invented. This advances the cause of science and leaves it open for improvement and new discoveries, which is crucial to science as Bacon explains:

> It is an idle thing, and shows a narrow mind, to think that the art of discovering the sciences may be invented and proposed in perfection from the beginning, so as to be afterwards only exercised and brought into use; for men should be made sensible that the solid and real arts of invention grow up and increase along with inventions themselves; so that when any one first comes to the thorough examination of a science, he should have some useful rules of discovery; but after he hath made a considerable progress in the science itself, he may, and ought, to find out new rules of invention, the better to lead him still further.[7]

Considering the important role poetry plays in the practice of science, it would be interesting to compare and contrast a piece of scientific poetry with a work of scientific prose to see how each type of language is similar and different in its treatment of the same subject. Examining what each achieves will offer us a glimpse into how language functions within science and how it can help drive the engine of invention forwards to improve it. Therefore, to compare, we have two textual artefacts that are each an example of scientific prose and scientific poetry. The first is a prose work from William Harvey whose pioneering study on blood circulation has earned him recognition as the father of the circulatory system. Harvey's work in *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus* or *On the Motion of the Heart and Blood in Animals* (1628) is important for two reasons: a) because it revolutionised our understanding of the circulatory system in human anatomy by explaining how blood is recycled in the body, and b) his scientific approach through dissections, experiments, and careful observation served as a model for all future scientific research.[8] The second textual artefact is a piece of poetry by Margaret Cavendish, Duchess of Newcastle, whose writings

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[5] Stephen H. Daniel, 'Myth and the Grammar of Discovery in Francis Bacon', *Philosophy & Rhetoric*, 15.4 (Fall 1982), 219-37, (p. 219) <http://www.jstor.org/stable/40237337> [25 Jan. 2016].
[6] Daniel, 'Myth and the Grammar of Discovery in Francis Bacon', p. 219.
[7] Francis Bacon, 'The Dignity and Advancement of Learning', in *The Physical and Metaphysical Works of Lord Bacon, Including His Dignity and Advancement of Learning, in Nine Books: and His Novum Organum; or, Precepts for the Interpretation of Nature*, ed. Joseph Devey (London, 1864) pp. 199-200.
[8] David Bardell, 'William Harvey, 1578-1657, Discoverer of the Circulation of Blood: In Commemoration of the 400th Anniversary of His Birth', *BioScience*, 28.4 (April 1978), 257-9, (p. 258) <http://www.jstor.org/stable/1307276> [2 Feb. 2016].

on science are invaluable because they document a woman's interest and engagement with a subject that has always been closed off to women due to institutional and ideological barriers that excluded women from becoming active members in scientific academies such as the Royal Society of London.[9] Cavendish's short poem entitled 'The Motion of the Blood' (1653) is singular because of how it directly addresses the science of the day by alluding to Harvey's *On the Motion of the Heart and Blood in Animals*. Cavendish's poem also raises the issue of poetry's role in science. As we compare and contrast Harvey's prose with Cavendish's poetry, the question that is continuously asked is: are the differences between prose and poetry so great that nothing can be gained in science from studying one with the other? Comparing these two textual artefacts will show where they differ but also where their similarities can help foster an interdisciplinary synthesis between science and literature.

When examining Harvey's prose language in *On the Motion of the Heart and Blood in Animals*, it is easy to see why his book would be looked upon as a paragon of seventeenth century science and a success of the new scientific method. As academic Walter Pagel had said of Harvey's book, it 'is famous for its small size, for its conciseness, its clear language, its logical structure in which fact follows on fact, argument on argument, proof on proof.'[10] Indeed, Harvey's choice of words through which he delivers his groundbreaking discovery of the flow of blood through the circulatory system is delivered with simple objectivity, as this excerpt demonstrates:

> [. . .] when I surveyed my mass of evidence, whether derived from vivisections, and my various reflections on them, or from the study of the ventricles of the heart and the vessels that enter into and issue from them, the symmetry and size of these conduits, [. . .] - or from observing the arrangement and intimate structure of the valves in particular, [. . .] I frequently and seriously bethought me, and long revolved in my mind, what might be the quantity of blood which was transmitted, in how short a time its passage might be effected, and the like. But not finding it possible that this could be supplied by the juices of the ingested aliment without the veins on the one hand becoming drained, and the arteries on the other getting ruptured through the excessive charge of blood, unless the blood should somehow find its way from the arteries into the veins, and so return to the right side of the heart, I began to think whether there might not be a motion, as it were, in a circle. Now this I afterwards found to be true; I finally saw that the blood, forced by the action of the left ventricle into the arteries, was distributed to the body at large, and its several parts, in the same manner as it is sent through the lungs, impelled by the right ventricle into the pulmonary artery, and that it then passed through the veins and along the

[9] Sylvia Bowerbank and Sara Mendelson, *Paper Bodies: A Margaret Cavendish Reader*, (Ontario, 2000), p. 25.
[10] Walter Pagel, 'William Harvey: Some Neglected Aspects of Medical History', *Journal of the Warburg and Courtauld Institutes*, 7.0 (1944), 144-53, (p.150) <http://www.jstor.org/stable/750386> [25 Jan. 2016].

> vena cava, and so round to the left ventricle in the manner already indicated.[11]

Given the complicated manner of the subject he is studying, Harvey succeeds in reducing the complex intricacies of human anatomy into a simple map that plots the movement of blood from point a to point b and back again. His plain prose relays this information effectively in a literal sense. There is, however, a drawback to Harvey's prose style. Due to his use of technical anatomical terms and nominal language, readers are unable to render in their minds a visualisation of the biological process he is describing. Harvey later counterbalances this inherent weakness of prose language's limitations by supplementing his prose with the figurative language of similes. Using similes, Harvey stirs the reader's imagination so that they may better visualise and understand why the blood has to circulate through the body as it does:

> This motion we may be allowed to call circular, in the same way as Aristotle says that the air and the rain emulate the circular motion of the superior bodies; for the moist earth, warmed by the sun, evaporates; the vapours drawn upwards are condensed, and descending in the form of rain, moisten the earth again [. . .] And similarly does it come to pass in the body, through the motion of the blood, that the various parts are nourished, cherished, quickened by the warmer, more perfect vaporous, spirituous, and, as I may say, alimentive blood; which, on the other hand, owing to its contact with these parts, becomes cooled, coagulated, and so to speak effete. It then returns to its sovereign, the heart, as if to its source, or to the inmost home of the body, there to recover its state of excellence or perfection. Here it renews its fluidity, natural heat, and becomes powerful, fervid, a kind of treasury of life, and impregnated with spirits, it might be said with balsam. Thence it is again dispersed. All this depends on the motion and action of the heart.[12]

The presence of figurative language in Harvey's prose blurs the traditional line that has been drawn in science to separate poetry and prose. The assumption has always been that the two are incompatible, but as Harvey's writing demonstrates, the two are not only compatible but they can work together to improve scientific writing and make it more effective and easy to understand. Similes, vivid in their poetic imagery, help fill the gaps left in the reader's mind by the limitations and deficiencies of prose language. Although prose might be able to tell readers where and how blood travels from one part of the heart to another part of the body, it cannot show or explain to readers the abstract process that occurs when the blood moves through the circulatory system. However, by taking this obscure abstract process in the body and comparing it to a similar process i.e. the precipitation cycle in nature, this scientific concept is easier to understand. The poetic language of similes can therefore play a positive role in science by explaining complex scientific concepts. At the same time, poetic language

[11] William Harvey, 'On the Motion of the Heart and Blood in Animals', *The Harvard Classics*, 38.3 (1909-1914), ch. VIII (New York: P.F. Collier & Son) <http://www.bartleby.com/38/3/8>. [2 Feb. 2016].
[12] Harvey, 'On the Motion of the Heart and Blood in Animals'.

can also help scientists like Harvey formulate hypotheses during the initial stage of the scientific method. As Harvey had demonstrated in his own writing in the excerpt that was previously cited, he had hypothesised that the blood moved through the body in a circular motion even before he had actual physical proof that it did. His theory was undoubtedly inspired not only by Aristotle's idea of the cycle of precipitation, but also by Aristotle's belief in the perfection that such a continuous and self-sustaining system of circular motion represents. Although Walter Pagel argues that Aristotle's philosophical speculations on the superiority of the circle movement cannot be directly found in Harvey's treatises, it is clear from our examination of the text, that Aristotle's appreciation for the circle's ability to paradoxically sustain, in equilibrium, states of both motion and rest, forwards and backwards movement influenced Harvey's thoughts during his initial observations of the heart and blood vessels.[13] This is evident at the point in Harvey's text where he first theorises that blood must be supplied throughout the body in a constant and unceasing circulatory motion otherwise the heart would be supplied by blood while 'the veins on the one hand becoming drained, and the arteries on the other getting ruptured through the excessive charge of blood'.[14] Harvey's conjectures that blood must therefore be constantly present in the vessels and the heart in a continuous flow in order for the system and the body to function properly, is a deduction inspired by Aristotle's idea of constant circular motion which was confirmed by Harvey's own observations. Aristotle's idea of the poetry of circular motion thus makes its way into Harvey's thinking and both influences and inspires his scientific study of the circulatory system. At the same time, poetic language in the form of similes and figurative language also helped Harvey to convey his scientific discovery effectively through his writing, thereby proving the benefits that poetry can bring to the field of science.

While Harvey's scientific writing contained poetic elements that worked well with his prose language to prove the compatibility of science and poetry, Margaret Cavendish's adaptation of Harvey's medical treatise into her poem entitled *The Motion of the Blood,* demonstrates how poetry can help advance science by pushing the scientific method's engine of invention forwards. Looking at the text, we immediately see the physical qualities of its form that marks it as a piece of poetry quite different from Harvey's prose in *On the Motion of the Heart and Blood in Animals*, even though the subject matter is the same and the title almost identical:

> Some by their industry and learning found,
> That all the blood like to the sea runs round;
> From two great arteries it doth begin,
> Runs through all veins, and so comes back again.
> The muscles like the tides do ebb and flow,
> According as the several spirits go;
> The sinews as small pipes come from the head,
> And they are all about the body spread,
> Through which the animal spirits are conveyed
> To every member, as the pipes are laid;

[13] Pagel, 'William Harvey: Some Neglected Aspects of Medical History', pp. 145-6.
[14] Harvey, 'On the Motion of the Heart and Blood in Animals'.

> And from those sinew's pipes each sense doth take
> Of those pure spirits, as they us do make.[15]

The twelve lines of verse are clearly organised into heroic couplets in iambic pentameter. These are the formal elements of the poem that makes it poetry -- a medium, we might add, that Cavendish felt safe to express her thoughts in because her 'errours might better passe there, then in prose; since poets write most fiction, and fiction is not given for truth, but pastime'.[16] Although the parameters of her poem constrict her in terms of meter and rhyme scheme, they paradoxically offer Cavendish the freedom to express her own opinion on Harvey and the circulatory system. As a woman interested in the new science but excluded from participating in the scientific academies of the Royal Society because of her gender, Cavendish is an outsider who nevertheless finds a way to engage with science by situating herself within the gender-free space poetry offers her that is outside of the institution's authority, beyond its masculine control of scientific discourse, its hegemony over scientific truth, and its tyranny over scientific prose. A close look comparing Harvey with Cavendish will reveal an important difference: Harvey was a male scientist who was able to perform dissections and carry out experiments whereas Cavendish was a woman and, ergo, was unable to do either. Cavendish however finds a way to perform her own symbolic dissection on the body through her poem by using similes that exposes the motions of the body's circulatory, muscular, and nervous systems to a comparison with the sea and tide. This is different from Harvey's use of Aristotle's imagery of the precipitation cycle because where Harvey's simile was used to illustrate the mechanical process of the blood through the body, Cavendish's similes are designed to draw the connection between the motion of blood with the motion of water in nature, thereby illustrating the organic nature of such biological processes. Cavendish's poem had referenced Harvey and his work evasively so as not to challenge its science directly, but subtly enough as to engage with it whilst expressing her own opinion on the subject. A close inspection of the poem will reveal a crucial difference between Harvey and Cavendish: her poem does not refer to the heart at all, neither in the title of her poem or anywhere in its verse. Cavendish has clearly taken Harvey's treatise and cut out the heart; an intriguing decision considering that Harvey's study on the heart was crucial to his scientific discovery of the circulation of blood. Her decision to excise the heart from her poem stems from Cavendish's vitalist and materialist views which made her sceptical of science and critical of its tendency to reduce nature's complexities into explanations of mere mechanical processes.[17] As Cavendish explains when she writes of 'art' or experimental science:

> [. . .] all mankind that ever have lived, or are at present living in this world, could never find out the truth of nature, even in the least of her parts, nay, not in themselves: for what man is he that knows the figurative corporeal

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[15] Margaret Cavendish, 'The Motion of the Blood', *Poems, and fancies written by the Right Honourable, the Lady Margaret Newcastle. (1653).* (London: Printed by T.R. for J. Martin, and J. Allestrye, 1653), *EEBO*, pp. 42-43.
[16] Cavendish, 'To Naturall Philosophers', *Poems, and fancies,* preface.
[17] Eugene Marshall, 'Margaret Cavendish (1623-73)', *Internet Encyclopedia of Philosophy* <http://www.iep.utm.edu/cavend-m/> [4 Feb. 2016].

> motions, which make him to be such a creature as man, or that make any part of him? And what man or art can inform us truly of the figurative motions that make the nature of blood, flesh, bones, etc. or can give a reason why the heart is triangular, and the head spherical, and so for every differently shaped part of his body? I will not say, but that man may guess at it, but not infallibly know it by any art[. . .].[18]

Therefore, although Cavendish had agreed with Harvey on the motion of the blood through the body, she did not agree with his decision to simplify the inner workings of the body's circulatory system into a mechanised process created by a pump-like heart. For Cavendish, the truth of the body's intricate actions and movements will always exceed the scientist's reach and refuse his complete mastery. Although this view might, at first glance, appear to be antagonistic towards all science and scientific advancement, it is not when we consider that Bacon himself had argued that science is not perfect and that it cannot grow idle but must constantly reinvent itself in its method in order to progress.[19] Cavendish's refusal to include Harvey's heart in her poem is therefore a cleverly veiled message from an excommunicated woman to the consecrated world of male-dominated science, that it must check itself against its pride of resting on discovered 'truths' otherwise it might grow resistant to change and future advancement. Like her poem's emphasis on the motion of the blood through the body, the emphasis of science should be upon moving constantly and never resting on the stasis of known facts. Science and the male scientist's obsession with controlling nature is also the wrong attitude to have, as Cavendish explains in her response to Robert Hooke's[20] remark that science and mechanical technology can help mankind exert their power over nature:

> [. . .] I do not understand, first, what they mean by our power over natural causes and effects: for we have no power at all over natural causes and effects [. . .] neither can natural causes nor effects be overpowered by man so, as if man was a degree above nature [. . .] for man is but a small part, and his powers are but particular actions of nature, and therefore he cannot have a supreme and absolute power.[21]

Humanity, like the body Cavendish depicts that has blood that flows like the river to the sea and muscles that expand and contract like the ebb and flow of the tides, should imagine itself as a part of nature containing within ourselves the same patterns that can be observed in nature; making us reflections of it and not in any way superior to it. Instead of seeking to control nature through science, we should, like Cavendish, acknowledge that science will never completely discover all of nature's truth and that certain things will remain beyond the abilities of even science to explain. Cavendish's short scientific poem therefore challenges

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[18] Margaret Cavendish, *Observations Upon Experimental Philosophy,* ed. Eileen O'Neill (Cambridge, 2001) p. 201.
[19] Francis Bacon, 'The Dignity and Advancement of Learning', pp. 199-200.
[20] Robert Hooke was a scientist who pioneered the use of microscopes and was a supporter of the use of mechanical technology in scientific study. Cavendish here is responding to his seminal work *Micrographia: or Some Physiological Descriptions of Minute Bodies Made By Magnifying Glasses. With Observations and Inquiries Thereupon.* (1665).
[21] Margaret Cavendish, *Observations Upon Experimental Philosophy,* p. 49.

science's discrimination not only against poetry, but also its discrimination against women like her who have much to say about aggressive seventeenth century masculine attitudes towards scientific practices.

In a study that has crossed the disciplines of science and literature, a comparison of William Harvey's prose on the circulatory system with that of Margaret Cavendish's poetry have brought forth both similarities and differences between the two. Nevertheless, there has been no difference so great between them that nothing can be gained from analysing them together. It has always been a point of concern with interdisciplinarity, that research which crosses the boundaries between disciplines might not be possible considering that it runs counterintuitive to the traditional view of knowledge as being divided into distinct branches of specialised subjects -- too different in their divergence to ever come together in a study. However, as this research has shown, crossing the divide between disciplines and between two different artefacts that intersect on a common theme is not only possible, it is also productive. Analysing the language of science in Harvey's prose and Cavendish's poetry has closed the gap between literature and science by demonstrating that an interdisciplinary study of the two has shown how poetry aids scientific thinking and writing. At the same time, this interdisciplinary study has also help expose deep social issues related to power and gender that are embedded within the supposedly pure and sterile language of seventeenth century science.

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