Taft Summer Research Fellowship Cover Sheet

Checklist

- Signed Cover Sheet
- Project Description (800-1200 words)
- Supplement explanation, if necessary
- 2 page CV

Review Taft website for full application guidelines.

Date of Application: *2/3/13*

Name, Department, Rank*: Zvi Biener, Philosophy, Assistant Professor*

Time Period: Summer *2013*

Location: *Cincinnati*

Title of Project*: The Life Sciences in the Scientific Revolution: The Case of Isaac Newton and the Physiology of Perception*

Requested Research Supplement (if any): $8000

Probable Results of a Grant (such as external funding, publications, and presentations): *Publication*

Other Funding Applied For or Received for This Project (list source and amounts requested and awarded):

*** Note:** this grant is for non-teaching quarters without pay and leave quarters without pay. *****

Taft Grants Received in the Last Five Years:

1. Type and Dates: Publication Cost, Jan 8, 2013
   Amount: $990.00
   Project Title: *Newton and Empiricism (Edited Volume)*
   Resulting Publications and Presentations: Newton and Empiricism volume, currently in preparation for Oxford University Press.

2. Type and Dates: Competitive Lecture Award, March 5, 2012
   Amount: $2648.00
   Project Title: Charles Wolfe Lecture on the Medical Sciences in Early Modernity
   Resulting Publications and Presentations: Lectures delivered on May 10, 2012.

3. Type and Dates:
   Amount:
   Project Title:
   Resulting Publications and Presentations:

4. Type and Dates:
   Amount:
   Project Title:
   Resulting Publications and Presentations:

*** Note:** this grant is for non-teaching quarters without pay and leave quarters without pay. *****

The Life Sciences in the Scientific Revolution: The Case of Isaac Newton and the Physiology of Perception

Zvi Biener
Assistant Professor, Philosophy

Jan 28, 2013
Word count: 1184

1. Thesis, Background, and Significance

Few know that Sir Isaac Newton—discoverer of classical physics and co-inventor of the calculus—was a biologist. And not only was he a biologist, but his research on human sensory perception helped motivated his account of universal gravitation and gravitation's relation to space and matter. *Newton's experimental physiology motivated key components of his universal, mathematical physics*.

Or so I argue.

The standard story regarding the scientific revolution is this: the basis of modern science was laid down in western and southern Europe during the Renaissance and seventeenth century, first by artists and artisans (Da Vinci, Brunelleschi, Tartaglia) and then by mathematicians and mathematical physicists (Galileo, Fermat, Newton). Once mathematical physics was off and running, other sciences followed suit, yet delayed by decades and even centuries: first came chemistry, then the earth sciences and biology, then modern psychology, anthropology, and the social sciences. Activity in certain disciplines—geography, botany, and zoology—remained fairly constant, but these did not come into their modern "scientific" guise until well after the birth of mathematical physics. Mathematical physics, the story goes, ushered in modern science, while the other disciplines only belatedly learned their lessons from mathematical physics.

Recent scholarship has revealed that this standard story is inaccurate and quite dismissive of the early importance of the life sciences and medicine to the arc of the scientific revolution. My project will contribute to this cutting-edge trend by stressing the importance of physiology in the work of Isaac Newton, undoubtedly the central figure of the scientific revolution.

2. Preliminary Findings

Newton was interested in biology since his student days. His Cambridge University notebooks attest that he not only studied the leading physiological theories of his time, but conducted experiments on the physiology of perception.[1] Interestingly, scholars have been well-aware of these notebooks for the past 40 years,[2] but not much has been made of the link between Newton's physiological experiments and his physics. The reason, I believe, is that the link runs through an unexpected disciplinary domain: theology.

For Newton, as humans are capable of perceiving and moving their bodies, so God is capable of perceiving and moving *all* bodies. Human action is limited to the human body, of course, but this was not a limit placed on God. Rather, Newton held that God's perception took place throughout the "immensity of space," throughout what he came to call, in analogy with the human body, God's "sensorium".[3] This physiological link provided him with an inductive research program *in physics*: In order to find out *how everything moves*—i.e., how God perceives and controls bodies—first determine the nature of human perception, then extrapolate to God. Physiology, through its analogy with divine perception, provided an inroad to physics.

To discover the nature of human perception, Newton conducted experiments on how images are transferred from the eyes to the brain. With rather striking proficiency, he was able to isolate the (tiny!) optic nerve and hypothesized that the only medium of image transmission consistent with the structure of the nerve was an exceedingly rare "aether," a substance so fine that it could transmit the motion of small particles but could not affect or be affected by them. Visual images from the eye, encoded by these small particles, thus 'floated' through the optic nerve to the brain, where they were decoded. Voluntary motions worked in the same way, but in reverse: motions started in the brain and lead out to the rest of the body through the 'aetherial' nervous system.

1. These notebooks are recently available at: `http://cudl.lib.cam.ac.uk/view/MS-ADD-03996/`.
2. J. E. McGuire and M. Tamny, *Certain Philosophical Questions: Newton's Trinity Notebook* (Cambridge: cup, 1983).
3. Isaac Newton, *The* Principia*, Mathematical Principles of Natural Philosophy: A New Translation*, trans. I. Bernard Cohen and Anne Whitman (Berkeley, California: University of California Press, 1999 (1726)), 942 and Martin Tamny, "Newton, Creation, and Perception," *Isis* 70, no. 1 (1979): 48–58.

When Newton was pressed by his contemporaries to explain how his curious "universal gravitation" worked, he invoked this aetherial mechanism. Gravity, by itself, was deemed rather counterintuitive in the late 17th century: How, after all, could every bit of matter in the universe attract every other bit of matter without the intervention of some medium? How does gravity 'reach' from one bit to another? An aetherial explanation answered such questions: what connects bits of matter to one another is the aether, an exceedingly rare substance that carries the gravitational force but does not affect and is not affected by bodies moving through it. Moreover, the aether behaves according to exact mathematical proportions because it is not a chaotic, unruly fluid, but is the mechanism by which God directs the motion of bodies according to his fixed laws; namely; the laws of motion and gravity. The physical explanation thus mirrored the physiological one.

Although this explanation of gravitation was mostly abandoned in the years after Newton's death, it is not a mere footnote in the history of science. Partly through Newton's repeated invocation of the "aether," the mysterious physical mechanism became entrenched in the language of physics, popping up over the next 300 years to explain any motion that seemed otherwise inexplicable. By the end of the 19th century, for example, light itself—then considered a wave, but a wave in what medium?—was explained as a propagation in the aether, a conception that was rejected only through the work of Einstein and the Michelson-Morely experiment. Mendeleev, in the 1870s, even tried to place the aether in his newly-formulated periodic table below the lightest element, hydrogen. Yet the beginnings of this story in Newton and his physiological research is mostly unknown and in need of significant historical and conceptual clarification.

3. Plan of Work

I intend to use the Taft Summer Support fellowship to flesh out the historical evidence for the above sketch and to answer the following crucial questions regarding Newton's use of the aether. First, little is known about the nature of Newton's experiments. Where did he learn to operate on the optic nerve? Did he interact with Cambridge surgeons and members of the faculty of medicine? What presuppositions were embodied in his experimental practice? Second, was his explanation of human perception novel or did he emulate explanations already provided by the physiologists of his time? If the latter, did those explanations have the same relation to theology as Newton's? Third, evidence should be found to reconcile Newton's avowed skepticism regarding arbitrary hypotheses in science ("*Hypothesim non fingo*") with his invocation of the aether. Since to modern eyes his 'divine physiology' seems rather arbitrary, on the basis of what evidence did argue that it was not an illicit extrapolation from necessarily human faculties? Finally, Newton's story needs to be tied back to the overall historiography of the scientific revolution, in order to further facilitate the re-

orientation of the standard account away from the primacy of the physical sciences, towards the now evident importance of the medical and life sciences.

Newton's notebooks are recently available online, so the budget request is for summer salary only. I am currently engaged in Newton-oriented projects (editing a volume for Oxford University Press and writing a commissioned essay on his scientific methodology), so am steeped in the subject matter. I am confident this project can be completed by Fall 2013. It will contribute both to my reputation as a Newton scholar and to my engagement with the cutting edge of scholarship on the life-sciences in the early-modern period.

4. Budget Justification

RESEARCH SUPPORT BUDGET BREAKDOWN	Amount
Summer Support	$8000
TOTAL REQUESTED:	**$8000**

All primary materials—Newton's notebooks and laboratory notes—are recently available through Cambridge University as high-res online scans. Material on other physiologists working in Cambridge in the late seventeenth century in available directly from Cambridge, or through secondary sources. Consequently, only summer support is requested.

Zvi Biener

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Education

2008 Ph. D. History and Philosophy of Science, *University of Pittsburgh*.

2005 M. A. Philosophy, *University of Pittsburgh*.

1995 B. A. Philosophy, with Honors, *Rutgers University*.

1995 B. A. Physics, with university wide High Honors, *Rutgers University*.

Academic Appointments

2011 – present. Assistant Professor (tenure-track). *University of Cincinnati*.

2008 – 2011. Assistant Professor (tenure-track). *Western Michigan University*.

2007 – 2008. Lecturer. *Western Michigan University*.

Publications

Edited Books:

Biener, Zvi and Schliesser, Eric (2013). *Newton & Empiricism*. Oxford University Press. Under Contract.

Peer Reviewed:

Biener, Zvi and Smeenk, Chris (*2012*). "Cotes' Queries: Newton's Empiricism and Conceptions of Matter". In Janiak, Andrew and Schliesser, Eric (eds.). *Interpreting Newton*, Cambridge University Press.

Biener, Zvi (2004). "Galileo's First New Science: The Science of Matter", *Perspectives on Science* 12 (3): 262-287.

Biener, Zvi and Smeenk, Chris (2004). "Pendulums, Pedagogy, and Matter: Lessons from the editing of Newton's Principia", *Science & Education* 13 (4-5): 309-320.
Reprinted in Matthews, M.R., Gauld, C.F. & Stinner, A. (eds.) (2005). *The Pendulum: Scientific, Historical, Philosophical and Educational Perspectives*, Springer, Dordrecht.

Invited:

Biener, Zvi (2014). "Newton's *Regulae Philosophandi*", in Smeenk, Chris and Schliesser, Eric (eds.) *The Oxford Handook for Isaac Newton*. Oxford University Press. Under Contract.

Machamer, Peter and Biener, Zvi (2004). "Physics", in *Europe 1450 to 1789: Encyclopedia of the Early Modern World*. New York: Charles Scribner's Sons.

Biener, Zvi and Smeenk, Christopher (Jan, 2003). "Review of I. B. Cohen and George Smith (eds.) The Cambridge Companion to Newton", in Gary Gutting (ed.) *Notre Dame Philosophy Reviews*, http://ndpr.nd.edu/review.cfm?id=1159.

Talks & Conference Presentations ('*' denotes an invited talk)

TBD. East Tennessee State University, April 2013.(*)

"Galileo's Scientific Engagement with Matter Theory (but Not the Matter Theory You Think)." Experimental Knowledge and the Deep Structure of the World. Virginia Tech, April 2011. (*)

"Hobbes on Geometry and the Structure of the Sciences". *Galileo, Descartes, Hobbes: Philosophy and Science, Politics and Religion during the Scientific Revolution*, a National Endowment for the Humanities Summer Seminar lead by Daniel Garber and Roger Ariew. Princeton University, July-August 2010.

"Newton's (Qualified) Rejection of Absolute Space." *The History of Philosophy of Science Bi-Annual Conference (HOPOS)*. Budapest, June 2010. [Accepted by peer-review process, but unable to attend]

"Cartesian Heterogenous Foundationalism." *Oxford Seminar in Early Modern Philosophy*. University of Oxford, October 2009.

"The Classification of Sciences and Foundationalism." *Universidade Estadual de Campinas*. Campinas, Brazil; September 2009. (*)

"Behind the Geometrical Method." *Bucharest-Princeton Seminar in Early-Modern Philosophy*. Bran, Romania; July 2009.

Invited participation in *Mapping the History and Philosophy of Science,* a workshop sponsored by the National Science Foundation and the James S. McDonnell Foundation. Indiana University, June 2009.

"Two Dogmas About Newton and Space". *Integrating History and Philosophy of Science Second Annual Conference*. University of Notre Dame, March 2009.

"Newton's Empiricism and the Changing Metaphysics of Void". *Lunchtime Talk Series*. Western Michigan University, February 2009. (*)

" 'Other sorts of bodies and another sort of vacuum' : Isaac Newton's Missing Theory of the Void and the Scope of Experimental Philosophy". *Bucharest-Princeton Seminar in Early-Modern Philosophy*. Malincrav, Romania; July 2008.

"Mixed-Mathematics as a Guide to Cartesian Foundationalism". *The History of Philosophy of Science Bi-Annual Conference (HOPOS)*. Vancouver, Canada; June 2008.

"The Limits of Evidential Reasoning in Newton's Argument for Universal Gravitation" (with Chris Smeenk). *Newton and/as Philosophy Conference*. University of Leiden, June 2007.

"How to Start a Revolution by Attending a University: The Importance of the Early-Modern Educational System for the Scientific Revolution". *The Center for West European Studies, University of Pittsburgh*. Pittsburgh, PA; January 2005. (*)

"Commentary on Howard Stein's `Newton: Philosophy of Inquiry and Metaphysics of Nature'" (with Chris Smeenk). *The American Philosophical Association (APA) Central Division Meeting.* Chicago, IL; April 2004. (*)

"Galileo and the Problem of Establishing the Middle as Mixed". *The Mid-West Seminar in the History of Early Modern Philosophy.* Madison, WI; December 2003.

"Galileo's Science of Matter". *The Fourth Athens-Pittsburgh Symposium in the History and Philosophy of Science and Technology: Proof & Demonstration in Philosophy and Science*. Delphi, Greece; June 2003.

"Does Gravity Feign?" (with Chris Smeenk). *The International Working Group on the History of Philosophy of Science (HOPOS)*. Toronto, Canada; June 2002.

"Is Gravity at the Heart of the Matter? Mathematics and Philosophy in the Newton-Cotes Correspondence" (with Chris Smeenk). *The Canadian Society for the History and Philosophy of Science*. Montreal, Canada, May 2002.

Recent Fellowships and Awards

2011 Taft Research Center Publication Costs Award ($990), University of Cincinnati.

University Research Grant Program ($6500), University of Cincinnati.

2010 College of Arts and Sciences Teachings and Research Award ($750), Western Michigan University.

National Endowment for the Humanities Summer Fellow. Princeton University - July-August 2010, for *Galileo, Descartes, Hobbes: Philosophy and Science, Politics and Religion during the Scientific Revolution*, a summer seminar lead by Daniel Garber and Roger Ariew.

Faculty Research and Creative Activities Award (FRACAA) ($10,000), Western Michigan University. (Award for the construction of a visual database of the history of science and philosophy).

The International Education Faculty Development Fund Award ($1000), Western Michigan University. (Awarded for projects promoting internationalization at Western Michigan University).

College of Arts and Sciences Teachings and Research Award ($600), Western Michigan University.

2009 Faculty Research Travel Fund Award ($850), Western Michigan University. (For Academic Year 2009/2010)

College of Arts and Sciences Teachings and Research Award ($750), Western Michigan University.