

The Beautiful Scheme: Christine Ladd-Franklin and the
Expansion of Logical Methodology

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Introduction

In 1896, the leadership of the American Psychological Association determined that something had to be done about the philosophers in their midst. The “intrusion of the philosophical camel into the psychological tent” had become markedly more visible, with a plurality of the papers presented each year being, in the eyes of the body, notably philosophical in nature.¹ Psychology and philosophy had clear overlaps and obvious alliances: both dealt with the inner-workings of human existence as expressed by the depths of the mind. But, as the century neared its close, the Association defined its purpose as “the advancement of psychology as a science.”² The philosophers were not interested in such advancement, and thus were dropped from the Association’s field of discourse.

The philosophers did not protest this exclusion. They, too, hoped to better define their role within the intellectual community. In 1901, a select group of leading American philosophers convened the first meeting of the American Philosophical Association. Not all their contemporaries thought this was a good idea. William James, the premier American philosopher and leading psychologist at the time, expressed his doubts. “I don’t foresee much good in a Philosophical Society,” he wrote upon being invited to attend the conference. “Philosophical discussion proper only succeeds between intimates who have learned how to converse by months of weary trial and failure. The philosopher is a lone beast dwelling in his individual burrow. Count me *out!*”³

¹ H.N. Gardiner, “The First Twenty-Five Years of the American Philosophical Association,” *The Philosophical Review* 35(1926), 146.

² Gardiner, “The First Twenty-Five Years,” 145.

³ William James, Letter to H.N. Gardiner, 14 November 1901. *The Letters of William James Vol. II*, (Project Gutenberg, 2011).

Many prominent American philosophers, however, readily counted themselves in. James himself soon came around to the idea, joining the APA in 1904 and eventually becoming its sixth president. In 1901, though, the association met without him. Forty leading figures in philosophy were present, including George Stuart Fullerton of Columbia and Josiah Royce of Harvard. This first meeting was held at Columbia University's Earl Hall, during the university's Easter break, where members were welcomed by Columbia's President and APA member Nicholas Murray Butler.^{4,5}

James Edwin Creighton of Cornell University delivered the association's inaugural Presidential Address, aptly discussing "The Purposes of a Philosophical Association." Creighton noted that he was aware there was a "not merely imaginary danger" in convening such an association that may claim to speak on behalf of the whole of American philosophy. But, he affirmed, a cooperative body is necessary to "discover the effort of the individual to free himself from the idols of the cave, by appealing to the reason of his fellows to confirm or correct his own subjective opinions." He continued: "We have learned that to isolate oneself intellectually is to render one's work unfruitful."⁶ He explained that convening such an association may present a way to save philosophy from irrelevance, as "philosophy must bake *some* bread; it must, like the other sciences, minister to human life...we cannot divorce the intellectual and the practical. Intelligence, when it is complete intelligence, is itself practical."⁷

One of the charter members of the Association, present for this first conference, was Christine Ladd-Franklin, then of Johns Hopkins University. She later praised the goals of the

⁴ Gardiner, "The First Twenty-Five Years," 149.

⁵ James Campbell, *A Thoughtful Profession: The Early Years of the American Philosophical Association* (Chicago: Open Court, 2006), 273.

⁶ James Edwin Creighton "The Purposes of a Philosophical Association," *Studies in Speculative Philosophy* (New York: The Macmillan Company, 1925), 7.

⁷ Creighton, "The Purposes of a Philosophical Association," 19.

APA, as a “plan, admirable in design, of paving the way for mutual understanding among the disputants by providing not only a summary of existing views in regard to the questions to be discussed, but also a set of definition of terms to be used in the discussion.”⁸ In effect, however, she thought that members of the discipline did not go far enough to ensure that philosophy was sufficiently prepared for a future of the significance it deserved.

The reconstitution of academic fields, as exemplified here by the psychologists and philosophers, played a prominent role in Ladd-Franklin’s intellectual formation. She was both a philosopher and a psychologist, and refused to limit herself to either field. As a logician, she worked to create procedures that could systematically apply mathematical concepts to philosophical and social questions. Like Creighton, she thought that philosophers needed to band together. Unlike Creighton, she proposed specific methodological means of doing so.

Ladd-Franklin returned to Columbia in 1909 as a part-time lecturer in philosophy and psychology. Her personal papers and a collection of her private correspondence were later donated to the university’s Rare Book and Manuscript Library. There are ninety-eight boxes, each containing dozens of folders and hundreds of papers, currently in the library’s possession. Most have barely been touched.

For this paper, I was only able to make preliminary headway in uncovering the trove of information and insight waiting in those boxes. In the following, I draw mainly from her unpublished notes on non-logic philosophy. These notes, often undated, span her years at Columbia. In them, she’s scratched parts of equations, charted the positions of her contemporaries, and scrawled pages of pages of sometimes illegible notes, too often in fading green ink on yellow paper. Some of her notes are in German or French, as she was conversant in

⁸ Christine Ladd-Franklin, “The Foundations of Philosophy: Explicit Primitives,” *The Journal of Philosophy, Psychology, and Scientific Methods* 8(1911), 711.

both. She's written a review for a science fiction novel and underlined passages in programs of conferences she attended. Also among the papers is a copy of an exam from an introductory philosophy course of May 1913, a 1911 booklet of undergraduate course listings, and many pages torn out of other books.

One note is titled *Value*. In this undated note, she does not present any conclusions on what has value or what should. She does, however, remark on the ways in which someone might attempt to find out. Valuing involves giving "ourselves more time to reflect upon remote consequences and to perform or care for summing up and weighing the total effects, both immediate and future." This pursuit of value may not produce any absolute results, for "far greater took pains to acquire and took no count of more accurate knowledge than we may happen to have regarding the matter in hand."⁹

Ladd-Franklin was not a philosopher who made sweeping proclamations. Though she certainly held strong personal values and morals, her philosophy skirted questions of religion, morality, and ethics. She wrote that unlike the preclusions of many of her contemporaries, "it is not for me to seek out either if gods exist or if they do not exist. Many things hinder me from this, notably the observing of the subject and the shortness of human life."¹⁰ The values she dealt with were generally mathematical, representational ones, to be used as tools by others in addressing these different types of philosophical questions. A section title of one of her most influential papers is "On the Constitution of the Universe." That title refers not to a metaphysical ascertainment but the strict technical definition of a mathematical universe, a concept which

⁹ Christine Ladd-Franklin, *Value*. n.d., Box 45, Christine Ladd-Franklin and Fabian Franklin Papers, 1900-1939. Rare Books and Manuscripts Library, Columbia University.

¹⁰ Christine Ladd-Franklin, n.d., Box 45, Christine Ladd-Franklin and Fabian Franklin Papers, 1900-1939. Rare Book and Manuscript Library, Columbia University.

mathematicians were formally developing at the time.¹¹ But the method of determining that she expresses in this note regarding values—taking in as much information as possible, and working to fully consider its antecedents and consequences—is ever present in her work in both philosophy and psychology.

Throughout her work, Ladd-Franklin urges her peers in academia to fully consider the bases of their proposals within the range of human thought. Examining her place in the history of American intellectual development is valuable in the way she describes in her note. It aims to be a small contribution to the project of “summing up and weighing the total effects.”

In the first chapter, I provide a relevant biographical sketch of Christine Ladd-Franklin’s life. I also present a brief historiography and argue that though she has not been left out of the historical record, that record does not reflect the fullness of her relevance. By focusing on her contributions and achievements specifically as a woman, we ignore her contributions and achievements. I hope, in part, to demonstrate the disservice women’s history does to the history of women. I do not claim that my approach manages to develop all matters of historical importance. Regrettably, I have mostly left out what were perhaps Ladd-Franklin’s most significant contributions to science, her theories of color vision. That work must be left for another time.

The second and third chapters discuss Ladd-Franklin’s theories of logic and their relevance to the history of American disciplinary development. The actual content of her contributions as well as the ways in which she operated within existing and changing academic structures serve to accentuate the way these changes affected what intellectual work was done in the century that followed. In the fourth and final chapter, I examine Ladd-Franklin’s less

¹¹ Christine Ladd, “On the Algebra of Logic,” in Charles Peirce, ed., *Studies in Logic* (Boston: Little, Brown, and Company, 1883), 61.

mathematically-focused (though still mathematically resonant) philosophical work in which she explicitly examines these developments and describes potential approaches for the future.

I walk past Columbia's Earl Hall, the location of that first APA meeting, nearly every day. It stands on a campus that bears evidence of the changes that Ladd-Franklin recognized and, at times, pushed against. Disciplines are separated into departments and buildings, divided by methodology and stated goals. But the divisions are losing their relevance. I say that I study history, but I've been lucky enough to study philosophy with mathematicians, psychology with artists, and literature with sociologists. I conclude by suggesting that my experience may reflect larger changes in the organization of knowledge in America. Christine Ladd-Franklin serves as a model of breaching disciplinary boundaries while also strengthening the content locked within them.

Chapter 1

Beginnings, Biography, and Bypassing Barriers

“In this progressive age,—this age of investigation and research,—when everything of the past, present, and future is challenged; when knowledge of the minutest atom is studied by the microscope, and with the telescope the broad arch of heaven is closely scanned for new constellations, and perhaps for a new sun with its revolving planets, one need not make any apology for a desire to learn something.”- Warren Ladd, *The Ladd Family*, 1890 [1].

Christine Ladd-Franklin was a logician, mathematician, and psychologist who lived and worked at the turn of the twentieth century. This was time of intellectual unrest, as academics categorized and separated knowledge into distinct disciplines by taxonomizing their methods of approaching an understanding of the world. Through her cross-disciplinary work, she chose to combine these now different types of knowledge instead of dividing them. Though Ladd-Franklin had specialties and preferences within these approaches, her life’s work reveals no preference for one, publishing in different fields from the beginning of her academic career into old age.

Ladd-Franklin’s intelligence is readily apparent, as evidenced by her success in pursuing her varied interests. Her awareness of her place in the then-changing world of academia, social norms, and philosophical institutions reveals the depth of her considerations. Her non-academic publications include dozens of letters to the editor expressing her ideas and aspirations for politics and changing social institutions. These aspirations are evident in her advocacy for women’s suffrage and general female participation in the public sphere. Though an empirical scientist by training and preference, she is better considered as an intellectual than an academic,

as her interests and contributions coalesced into patterns that reached much farther than the classroom or academic conference.

Ladd-Franklin enjoyed ideal circumstances for leading a life of intellectual curiosity, academic vigor, and assertive positions. Born in 1847 to Eliphalet Ladd and Augusta Niles Ladd in Windsor, Connecticut, she grew up as the beneficiary of two politically active and influential families, as both the Ladds and the Niles traced their ancestry to well-established early English settlers.¹ Her mother died when she was young, so she was raised in part by her grandmother and an aunt, who were likewise supportive of her academic endeavors. Her early education at Wesleyan Academy in Wilbraham, Massachusetts, an institution that claimed to epitomize the conviction that “education is wealth invested,” indicates that her family had means, and that they prioritized proper preparatory education.²

She attended Vassar College and graduated in 1869. Vassar had been founded only six years before she arrived there, in 1861, and Ladd-Franklin was a member of the college’s second graduating class.³ There, she studied mathematics, physics, and astronomy under the mentorship of Maria Mitchell, Vassar’s first professor. Mitchell was known for rousing her students in the middle of the night to observe planetary phenomena from the college’s domed observatory. She was also known for using that same observatory to host political speakers and discuss women’s issues.⁴ Upon graduation, Ladd-Franklin hoped to continue studying physics at a graduate level but found no experimental laboratory that would accept a woman. Graduate schools and designated university laboratories were relatively new concepts at the time. Only a handful of

¹ Warren Ladd, *The Ladd Family* (New Bedford: E. Anthony & Sons, 1890).

² David Sherman, *History of the Wesleyan Academy in Wilbraham, Massachusetts, 1817-1890* (Boston: McDonald & Gill Company, 1893), iii.

³ Homer Stavely, “Christine Ladd-Franklin,” Charlene Morrow and Teri Perl, ed., *Notable Women in Mathematics: A Biographical Dictionary* (Westport: Greenwood Press, 1998), 109.

⁴ Elizabeth Adams Daniels, “Maria Mitchell,” *Vassar Encyclopedia* (2005).

university-supported research laboratories existed, and they held tight to accepted norms meant to maintain the respectability of the burgeoning institutions. This meant not allowing women to participate. Instead, she taught math in high schools and published in mathematical journals in the United States and abroad. These journals had emerged throughout the eighteenth century, reflecting the professionalization of mathematics during that time. When Ladd began publishing, three American journals were in print, as well as a few more in Germany and Great Britain.⁵ During these years, she also sat in on math courses at Harvard and studied privately with a neighbor, Professor George Vose, while also teaching music and reading to students in the town of Washington, Pennsylvania.⁶ Vose was, at the time, a professor of mathematics and engineering at the nearby Williams and Jefferson College. He later taught civil engineering at Bowdoin College and the Massachusetts Institute of Technology, where he was known for his specialization in railroads. He also contributed to the MIT journal *The Mathematical Monthly* on the topics of analytical algebra and geometry.⁷ It is likely that he tutored Ladd in these topics, as she makes no mention of the best methods of railroad construction in mountain ranges, the real focus of Vose's expertise.⁸ Ladd wrote of these sessions that they provided a "common source of happiness unalloyed" and that Vose was "a man of genius."⁹ She preferred studying to teaching. That summer, she wrote that "at last I have done an unwomanly thing. I have violated the

⁵ Karen Hunger Parshall and David E. Rowe, *The Emergence of the American Mathematical Research Community, 1876-1900: J.J. Sylvester, Felix Klein and E.H. Moore* (Providence: American Mathematical Society, 1994), 51.

⁶ Colton Johnson, "Christine Ladd-Franklin," *Vassar Encyclopedia* (2008).

⁷ *Appletons' Cyclopaedia of American Biography*, "George Leonard Vose" (1900).

⁸ See George Vose, *Handbook of Railroad Construction* (Boston: J. Munroe and Company, 1857), and *Orographic Geology, or the Origin and Structure of Mountains* (Boston: Lee and Shepard, 1866).

⁹ *Christine Ladd-Franklin Diary*, 1 March 1871, Archives and Special Collections Library, Vassar College, Poughkeepsie, NY.

sanctities of my sphere,” by devoting herself to full-time study with Vose until the school year began again the next fall.¹⁰

In March of 1878, citing the positive reception of papers and solutions to problems she published in journals such as the *Educational Times* and the *Analyst*, she wrote to Professor James J. Sylvester at Johns Hopkins to ask to study mathematics under his tutelage. Hopkins had just opened in 1875, as the first American university devoted to research. Sylvester was Hopkins’s first professor of mathematics and was working to shape the department within the university’s framework of institutional research.¹¹ “It is my desire next year to listen to such of your mathematics lectures as I am able to comprehend,” she wrote to this giant in the field. “Will you kindly tell me whether the Johns Hopkins University will refuse to permit it on account of my sex?”¹²

Sylvester instructed one of his students, Fabian Franklin, to conduct a survey of Ladd’s work and determine the legitimacy of her request. He did so, listing her publications on a piece of lined paper, noting of the *Educational Times* that “she is frequently mentioned in that journal as having solved proposed problems.”¹³ Ladd’s inquiry was forwarded to the university’s president, Daniel Coit Gilman, and to the Board of Trustees. That April, Gilman wrote directly to Ladd, and told her, somewhat convolutedly, that “the Board of Trustees is not favorable to the admission of women as students of the University in the ordinary acceptance of that phrase, and therefore cannot grant your application in the extended form in which it comes before them.” However, because of Ladd’s “exceptional achievements as a mathematician,” they consented to

¹⁰ *Christine Ladd-Franklin Diary*, 16 July 1871.

¹¹ Parshall and Rowe, *The Emergence of the American Mathematical Research Community*, 53.

¹² Christine Ladd to James J. Sylvester, 27 March 1878, Daniel Coit Gilman Papers, Johns Hopkins University Archival Collections, Baltimore.

¹³ Fabian Franklin, “Articles in *The Analyst* by Miss Christine Ladd,” 1 April 1878, Daniel Coit Gilman Papers, Johns Hopkins University Archival Collections, Baltimore.

allow her to attend Sylvester's lectures.¹⁴ With that, Johns Hopkins granted her a “special status,” as a non-matriculated non-tuition paying student. They granted her the stipend of a fellow at the university without the title.

After a year of studying with Sylvester, Ladd began attending other classes, including those offered by Charles Sanders Peirce.¹⁵ Peirce had joined the Hopkins faculty that year in a non-tenured position in the philosophy department. Peirce, who did not succeed in retaining academic appointment after a short stint at Hopkins, was also notable in his resistance to confining himself to any particular academic field. Instead, he was “bent on laying hold of the interconnectedness of all things.”¹⁶ The son of the prodigious American mathematician Benjamin Peirce, he began his studies by working on mathematics under his father’s tutelage. He worked in the physical sciences of chemistry, metrology and astronomy, was one of the first experimental psychologists, and later became known for his work in semiotics, the philosophy of science, and evolutionary metaphysics.¹⁷ When Ladd encountered him, he working to develop a comprehensive system of notations for mathematical logic.¹⁸ He based this effort most directly on the work done by George Boole, an English mathematician and philosopher who published a revolutionary work in logic in 1847, the same year as Ladd-Franklin’s birth.¹⁹

¹⁴ Daniel Coit Gilman to Christine Ladd, 26 April 1878, Daniel Coit Gilman Papers, Johns Hopkins University Archival Collections, Baltimore.

¹⁵ Ahti-Veikko Pietarinen, “Christine Ladd-Franklin’s and Victoria Welby’s Correspondence with Charles Peirce,” *Semiotica* 196(2013).

¹⁶ John E. Smith, “Preface,” in Eugene Freeman, ed., *The Relevance of Charles Peirce* (La Salle: The Hegeler Institute, 1983), 9.

¹⁷ Joseph Brent, *Charles Sanders Peirce: A Life* (Bloomington: Indiana University Press, 1993).

¹⁸ Max H. Fisch, “Peirce’s General Theory of Signs,” in Thomas A. Sebeok, ed., *Sight, Sound, and Sense* (Bloomington: Indiana University Press, 1978), 33.

¹⁹ George Boole, *The Mathematical Analysis of Logic: Being an Essay towards a Calculus of Deductive Reasoning* (Cambridge: Macmillan, Barclay & Macmillan, 1847).

Ladd and Fabian Franklin, the graduate student and now young professor who had completed Sylvester's assignment to analyze her work, married in 1882. Fabian later recounted "as to how my wife and I first became interested in each other, strangely enough, it was through a long discussion we had together on the steps of one of the Johns Hopkins buildings, standing for hours on the steps, debating a point in logic."²⁰ They enjoyed a loving and supporting marriage—long discussions on campus steps proved to be a good place to start a relationship. Franklin wrote and published as well, though, unlike his wife, took his background in mathematics and applied it to economics and the social sciences. He published books titled *The Cost of Living*, *What Prohibition has Done to America*, and *Plain Talks on Economics*, as well as a political economic journal *The Weekly Review*.²¹ He also wrote a biography of Hopkins president Daniel Coit Gilman. Though Ladd-Franklin never pursued this form of applied mathematics formally, she found that an understanding of her husband's preferred realm was important part of claiming equal abilities and independence. Of political economy, she wrote "I did not understand it before I was married... Mr. Franklin smiled that superior masculine smile—so as soon as I could—after our wedding journey—I *studied* it, and I assure you I have felt like a different person ever since—also, his equal."²² Her inclination to claim social equality through intellectual equality recurred throughout her career in academia. Christine and Fabian produced two children together while at Hopkins. The first, a son, died in infancy. The second,

²⁰ Johnson, "Christine Ladd-Franklin."

²¹ John O'Connor and Edmund Robertson, "Fabian Franklin," *MacTutor History of Mathematics*, (Scotland: University of St. Andrews, 2015).

²² Christine Ladd-Franklin, untitled notes, n.d., Box 10, Christine Ladd-Franklin and Fabian Franklin Papers, 1900-1939. Rare Book and Manuscript Library, Columbia University. Cited in Scott Spillman, "Institutional Limits: Christine Ladd-Franklin, Fellowships, and American Women's Academic Careers, 1800-1920," *History of Education Quarterly*, 52(2012), 210.

Margaret, later became active in the women's suffrage movement. She published *The Case for Woman Suffrage*, a comprehensive bibliography on the topic, in 1913.²³

In 1883, Peirce compiled and published a collection of papers written by his graduate students in a volume called *Studies in Logic*. Ladd-Franklin contributed a piece titled "On the Algebra of Logic."²⁴ Her academic peers granted this work high praise.²⁵ Peirce himself drew special attention to her paper (he refers to her both as "Miss Ladd" and "Mrs. Fabian Franklin," as she married Fabian during the course of publication. She began referring to herself as the hyphenated Ladd-Franklin once married) in the introduction of the collection, in which he praises her "facility" in the improvements she makes to the overall system, which, along with the work of her classmates, were "so instructive" to even the demanding Peirce.²⁶ He later considered her one of his "ablest students."²⁷ Harvard philosopher Josiah Royce wrote that he considered her contribution "a crowning activity," while other philosophers hazarded a hyperbolic comparison to Aristotle.²⁸ She began a correspondence with eminent philosopher and psychologist William James who, despite his prominence as leader in many fields, praised her for her wide-ranging abilities that in some ways surpassed his own. "As for your logical papers," he wrote to her in 1890, "you can perhaps now understand why I have not read them...[I am]

²³ Margaret Ladd-Franklin, *The Case for Woman Suffrage* (New York: National College Equal Suffrage League, 1913).

²⁴ Charles S. Peirce, *Studies in Logic* (Boston: Little, Brown, and Company, 1883).

²⁵ Stevens and Gardner, *The Women of Psychology*, 118.

²⁶ Peirce, *Studies in Logic*, iii.

²⁷ Max H. Fisch, "The Range of Peirce's Relevance," in Eugene Freeman, ed., *The Relevance of Charles Peirce* (La Salle: The Hegeler Institute, 1983), 17. Interestingly enough, the other one of the two students referred to as "ablest" was the psychologist Joseph Jastrow, son of the Talmudist Marcus Jastrow. Jastrow was noted for his development of randomization and blinding in experimental design.

²⁸ Dorothea J. Hurvick, "Ladd-Franklin, Christine" in Edward T. James, ed., *Notable American Women: 1607-1950* (Cambridge: Harvard University Press, 1974), 357.

absolutely non-mathematical and non-higher logical.”²⁹ In an explanatory paper a half century later, in 1927, logician Eugene Shen even went as far as to proclaim that “no scheme in logic is more beautiful than that based on the eight propositions of Dr. Ladd-Franklin.”

Ladd-Franklin did not consider herself exclusively a student of philosophy. At that point, her published work could be considered strictly mathematical, and she continued her coursework primarily in mathematics. But these interests seem to have led her to psychology which was, at the time, breaking from its earlier status as a subfield of philosophy. Psychology, along with logic, became the focus of her life’s work.

How exactly that interest developed has not been well documented, but likely it began with her work regarding the horopter, the abstract line on which the locus points of binocular vision lie. Solving the problem of the horopter was a largely geometrical venture, and therefore fitting of her mathematical interests.^{30,31} The publication of her paper “A Method for the Experimental Determination of the Horopter” in 1887 marked the beginning of her extended study of vision.³²

In 1891, Fabian Franklin took a sabbatical leave from Johns Hopkins, and the Ladd-Franklin family travelled to Germany. There, while Fabian looked after Margaret, Ladd-Franklin conducted laboratory experiments in both Göttingen with G. E. Müller and in Berlin with Arthur König, the latter in the laboratory of Hermann von Helmholtz.³³ German universities were

²⁹ William James to Christine Ladd-Franklin, in Frederick J. Down Scott, ed., *William James Selected Unpublished Correspondence, 1885-1910* (Columbus: Ohio State University Press, 1986), 65.

³⁰ Steven Yantis and Richard A. Abrams, *Sensation and Perception*, 2nd ed. (New York: Worth Publishers, 2017), 236.

³¹ Stevens and Gardner, *The Women of Psychology*, 119.

³² Christine Ladd-Franklin, “A Method for the Experimental Determination of the Horopter,” *The American Journal of Psychology*, 1(1887), 99-111.

³³ Laurel Furumoto, “Christine Ladd-Franklin’s Color Theory: Strategy for Claiming Authority?” in Helmut E. Adler and Robert W. Rieber, ed., *Aspects of the History of Psychology in America 1892/1992* (New York: American Psychological Association, 1994), 92.

generally more prohibitive towards women than their American counterparts but made special exceptions for foreign women.³⁴ Müller and von Helmholtz were two of the most prominent experimental psychologists at the time. This brought Ladd-Franklin into one of the defining controversies in the history of psychology, as each side represented different approaches. Helmholtz backed the trichromatic theory, one of the major theories of color vision. His opponent, Ewald Hering, proposed a theory of three opponent color pairs, which Müller supported.³⁵ The differences between their theories extended farther than color. Helmholtz and Hering disagreed about fundamental aspects of how to approach psychology. Hering's account is generally a Nativist one, which assumes that the visual experience is inborn. Helmholtz, on the other hand, tended to be an Empiricist, proposing that at least some of the ability to perceive a visual world is the result of learning.³⁶ The fundamental positions behind their claims emphasize the deep theoretical connections between philosophy and psychology. Their conclusions, however, were not abstract, and were subjected to experimental testing as the technology became available. Ladd-Franklin worked on the same question of color vision right amid this famous controversy. She observed that these leading ideas presented “two utterly diverse explanations of the phenomena of color vision, each of which took account of one-half of the facts of color and wholly ignored the other half.”³⁷ Characteristically, Ladd-Franklin offered a new and novel idea that straddled the two by focusing on what she saw to be the evolutionary aspects of color vision, which ended up contributing to the photochemical theory of vision. Her approach was methodological and emphasized a consideration of all observable factors to produce a cogent

³⁴ Spillman, “Institutional Limits,” 198.

³⁵ Yantis and Abrams, *Sensation and Perception*, 207.

³⁶ Lydia Patton, “Hermann von Helmholtz” in Edward N. Zalta, ed., *The Stanford Encyclopedia of Philosophy*, 2018.

³⁷ Christine Ladd-Franklin, *The Biographical Cyclopaedia of American Women*, 3 vols. (New York: Williams-Wiley, 1928), 3:139. Cited in Furumoto, “Christine Ladd-Franklin's Color Theory,” 91.

conclusion.³⁸ She presented her findings at the 1892 International Congress of Psychology in London.³⁹ Once again, Ladd-Franklin won the praise of academic peers, this time from experimental psychologists rather than philosophers.⁴⁰

Upon her return to the United States, Ladd-Franklin continued publishing in color vision and philosophy. She returned to Europe in 1901 to continue her work in optics. While there, she served as the associate editor for the Logic and Psychology sections of Princeton psychologist James M. Baldwin's *Dictionary of Philosophy and Psychology*. She also contributed dozens of articles to the dictionary, among them lengthy expositions on "Laws of Thought," "Syllogism," "Symbolic Logic," and "Vision."⁴¹ The dictionary was comprehensive and definitive: for perusers of this encyclopedia, the Ladd-Franklin systems of logic and theories of vision were accepted as factual. Her selection to write these sections reveals Baldwin and other peers' high appraisal of her work.

In 1904, she began teaching psychology and logic as a part-time unpaid lecturer at Johns Hopkins. Five years later, her husband decided to leave academia to become the associate editor of the *New York Evening Post*. Ladd-Franklin secured an appointment at Columbia University, again as an unpaid lecturer in psychology and logic. This produced a "sudden spurt in creative activity" and she began writing extensively about nerve fibers in the retina.⁴² Ladd-Franklin

³⁸ Stanley Finger, *Origins of Neuroscience* (New York: Oxford University Press, 1994), 104.

³⁹ Christine Ladd-Franklin, *Colour and Colour Theories* (New York: Harcourt, Brace, and Company, 1932), viii.

⁴⁰ Elizabeth Scarborough and Laurel Furumoto, *Untold Stories: The First Generation of American Women Psychologists* (New York: Columbia University Press, 1987), 123.

⁴¹ James Mark Baldwin, ed., *Dictionary of Philosophy and Psychology* (New York: The MacMillan Company, 1911).

⁴² Stevens and Gardner, *The Women of Psychology*, 120.

continued to be productive in this position, publishing dozens of scientific papers as well as opinion pieces and letter-to-the-editor for twenty years, nearly up to her death in 1930.⁴³

The fragments of Ladd-Franklin's life and career can be fitted into neat categories with a discernible progression and clear transitions, as she kept her work in both logic and psychology distinct from each other. Her logic will be the focus of the following pages. For Ladd-Franklin, though, these topics were part of a larger intellectual tapestry with which she considered the world. She was both a mathematically-inclined psychologist and a mathematician who cared about the workings of the mind. Throughout her career, she entered from the edge of disciplines, almost by chance and convenience, only suddenly to take starring roles in their developments. She did so while maintaining intellectual consistency. Though she approached her chosen projects in deep ways, she also held a broad understanding of the relationships between different topics and modes of thought which allowed her to excel in so many seemingly discrete fields.

Before offering a serious treatment of Ladd-Franklin's work, opinions, and place in history, it is important to recount how previous intellectual biographers have approached discussing her relevance. To claim that historians have forgotten her, or not given her fitting historical attention is inaccurate. Major American biographical encyclopedias of both mathematics and science give her an entry, and her work in logic (which has held up better to modern scientific developments than her work in psychology) continues to be cited as critical to the development of mathematical logic, either in relation to Peirce's work or on its own. These recognitions, however, while laudatory, are rarely more than cursory. Serious analysis of her contributions requires consideration of her time and her modes of intellectual approach.

⁴³ Thomas C. Cadwaller and Joyce V. Cadwaller, "Christine Ladd-Franklin," in Agnes O'Connell and Nancy Felipe Russo, ed., *Women of Psychology: A Bio-Bibliographic Sourcebook* (Westport: Greenwood Press, 1990), 223.

In the absence of this contextual examination, historians and writers depict Christine Ladd-Franklin as a revered figure in the history of women in science. So, for example, her biographical entry in *Notable Mathematicians* devotes a section to her “opening closed doors” for women.⁴⁴ No similar consideration of social influences is given to the male mathematicians who proceed and follow her alphabetically in this encyclopedia. Other work, such as Margaret Rossiter’s extensive treatment in *Women Scientists in America* focus on the “struggles and strategies” women like Ladd-Franklin experienced and employed to make their way in academia.⁴⁵ Ladd-Franklin’s role in these accounts is not that of victim to her time period or societal norms. If anything, they present her as revolutionary, a hero for women who persevered despite the forces working against her. Homer Stavley in *Notable Women in Mathematics* describes her as someone whose “course ran against the current of male privilege and before the wind of women’s advancement—she was quite a sailor.”⁴⁶ The same theme is especially apparent in the work of Elizabeth Scarborough and Laurel Furumoto, who feature Ladd-Franklin in a chapter on “collegial exclusion.” They illuminatingly trace her efforts to participate professionally and socially in areas dominated (and often exclusively populated by) men.⁴⁷

Women’s history is an important area of study, and Ladd-Franklin’s role in increasing the presence and acceptance of female scientists is important. She devoted time engaging with her role as a woman in academic circles and in America in general. She was a staunch advocate for

⁴⁴ Robyn V. Young, ed. *Notable Mathematicians From Ancient Times to the Present* (Detroit: Gale Research, 1998), 295-296.

⁴⁵ Margaret W. Rossiter, *Women Scientists in America* (Baltimore: Johns Hopkins University Press, 1982).

⁴⁶ Stavely, “Christine Ladd-Franklin,” 112.

⁴⁷ Scarborough and Furumoto, *Untold Stories*, 110-129.

women's rights, and a fiercely committed suffragette.⁴⁸ But that Ladd-Franklin was a woman is not what makes her interesting, or what makes her contributions worth studying.

She will be considered here not as a female academic but as a polymath in an intellectual era increasingly suspicious of those who resisted disciplinary confinement, who happened to be female. Her contributions were not especially "feminine," if that term can be used at all, nor are they only matters of interest because of her position as a woman. She is interesting and important in her own right, and not because of the odds she faced as a woman to take up the many challenging problems she did.

Her womanhood and her domestic circumstances more generally, however, do play an important role in her biography and help account for the ways in which she became involved in so many different disciplines at such opportune times. Her gender operates in her biography as a confounding factor to a straightforward academic path. She walked such an individualized path partly because society, especially as expressed in the emergent university structure, locked her out of so many institutional norms and channels of support.

A brief restatement of her academic progression demonstrates how being a woman contributed to her non-traditional progression. At Vassar, Ladd-Franklin excelled at math and wanted to pursue physics. When no experimental physics laboratory would take her, as very few existed, and those that did were considered by practitioners to be outside the feminine domain, she resigned herself to mathematics alone.⁴⁹ Her interest and writing in math caught the attention of James Sylvester who found a place for her at Johns Hopkins. She came to logic and psychology through math, and from logic to more expansive forms of philosophy. The path the considerations of her gender directed her to take led her to these areas—not the fact that she was

⁴⁸ Cadwaller and Cadwaller, *Women in Psychology*, 226.

⁴⁹ Stevens and Gardner, *The Women of Psychology*, 119.

a woman itself. So too with her next major contribution, in the field of color vision. She ended up in Germany not because of an opportunity given to her but because of the sabbatical her husband took. As no university ever granted Ladd-Franklin permanent professorship, she enjoyed some mobility that would have otherwise been difficult. Traveling with Fabian, however, allowed her to demand a place in European laboratories which accepted her in ways that American ones did not. She ended up in New York and at Columbia as she once again followed Fabian for his work, not for her own academic priorities. That her professional career was tied to her husband's is a distinctly female phenomenon. She also benefited from Fabian's various positions by relying on his salary while focusing on her own, unpaid projects. This advantaged her over other women, who did not have such financial security, more than it advantaged her over men, who could rely on being paid for their own intellectual work. The actual contributions she made, however, are not distinctly feminine. Christine Ladd-Franklin's gender necessitated roundabout circuits through academia which allowed her the opportunities to make the contributions she did. How exactly she made these contributions, and what drove her to do so at all, however, are uniquely her own. A detailed analysis of her work in logic demonstrates how she developed and advocated for an academic agenda that starkly contrasted with those forming around her.

Chapter 2

The Universe of Mortal Men: Syllogisms, Semiotics, and the Algebra of Logic

“The motivations and activities of scholars and scientists and professionals are of significance not simply to a coterie of intellectual historians but to all who would understand the nature of American society in the twentieth century and the forces that brought it into being. To understand the developing ecology of knowledge is to understand a fundamental aspect of our world.”—Charles Rosenberg, “Towards an Ecology of Knowledge,” 1979 [1].

Charles Peirce chose “On the Algebra of Logic,” Ladd-Franklin’s first major paper in logic, to include in his 1883 collection of graduate student work. This fifty-five-page account, rivaled in length only by Peirce’s own submission, provides a dense yet clear description of the methods of argument and symbolism for an improved comprehensive logical system of analytical reasoning. Her introductory remarks reveal her awareness of her place in the history and development of her new chosen field. “There are in existence five algebras of logic,” she writes, “those of Boole, Jevons, Schröder, MacColl and Peirce—of which the latter are all modifications, more or less slight, of Boole. I propose to add one more to that number.”¹ Her system sets out to improve on those of her predecessors in two ways. Ladd-Franklin’s system, she explains by way of modest introduction, differs by making explicit use of the copula—representations of connecting words such as the verb “to be”—and in the form in which it expresses conclusions. Her proposed system used these features to express eight distinct logical statements. These statements, in turn, allowed for a collapse of the various modes of syllogism,

¹ Christine Ladd, “On the Algebra of Logic,” 17.

which had been treated as the reigning mode of logical statement since Aristotle, into a single symmetrical formula, which she names the antilogism. The eight statements will be treated here; the antilogism in the following chapter.

These proposed developments are more than just technicalities of analysis: they comprise of Ladd-Franklin's evaluation of the overlapping fields of logic and philosophy as they stood and hint to her proposal for reform. Likewise, the specific framing of her contribution constitutes more than just the formality of acknowledging her influences. Rather, this introductory passage stakes her claim as the bearer of a recognized tradition. Her acknowledgement of the history of the form represents a key tenet of her philosophy which she concurrently developed around this logical system.

The field of logic has been one of unsure classification from its earliest formal presentations. William Kneale and Martha Kneale, authors of the compendious *The Development of Logic*, define the study of logic, in its most basic sense, as the study of valid argument combined with "the reflection upon principles of validity."² (It seems pertinent to note in a paper that aims, in part, to de-emphasize the peculiarity of a female logician that this first chapter, as well as the following two in the volume, are the work of Martha Kneale, though William Kneale is granted first authorship throughout.³) The Kneales argue that though formal logical study preceded even Aristotle, such as in the fields of geometry and legal sophistry, Aristotle's writings, collected after his death in 322 B.C., constitute the first formal treatment of logic as a field of study. This early logic displayed strong ties to linguistic analysis and areas of philosophy now classified as metaphysics. If logic is argument, it makes sense that it includes an

² William Kneale and Martha Kneale, *The Development of Logic* (London: Oxford University Press, 1962), 1.

³ Kneale and Kneale, *Development of Logic*, vi.

investigation of the arguers' language as well as the contents of their arguments. Aristotle's logic has direct implications on his theories of mind, thought, and truth. The forms of logical reasoning he lays out, most notably the syllogism, continue to provide the basis for modes of mathematical reasoning and scientific analysis. A syllogism is a type of logical argument that takes at least two propositions, which are assumed to be true, and applies deduction to arrive at a conclusion. To use an example employed by Ladd-Franklin, "when we infer from 'all kings are tyrants,' and 'all tyrants are assassinated,' that 'all kings are assassinated,' what we do is to gather up all the information that is conveyed in both premises together, exclusive of that which concerns tyrants."⁴ The syllogism works by identifying the information that is shared by both of the premises, considering the shared subject's implications, and providing a conclusion.

Because of the different forms propositions may take, and the meaning those forms may carry, a syllogism may take more than one pattern, referred to as syllogistic modes or types. For proper classical analysis, a syllogism must be identified in one of various syllogistic types. Logicians following Aristotle quantified and categorized these modes. The full range of the deductive language identifies and form 256 distinct types of syllogism—or even 512, trivially, if the count were to include changing the order of the premises.⁵ Aristotle's syllogisms have been treated by ancient, medieval, and modern logicians at length and constitute the crux of Ladd-Franklin's eventual proposal.

Peirce grounded much of his logic in his work in semiotics, the study and use of signs and symbols. Logic was "the science of the conditions which enable symbols in general to refer

⁴ Christine Ladd-Franklin, "On Some Characteristics of Symbolic Logic," *The American Journal of Philosophy*, 2(1889), 543.

⁵ Robin Smith, "Aristotle's Logic," in Edward N. Zalta, ed., *The Stanford Encyclopedia of Philosophy*, 2018.

to objects.”⁶ In a lecture on “The Logic of Science,” at Harvard University in 1865, he divided logic into psychological and non-psychological forms. A psychological approach would take into consideration the mechanics of how people think and symbolize in logical forms, as opposed to just considering the forms themselves.⁷ He defined non-psychological logic as “the science of the conditions which enable symbols in general to refer to objects.”⁸ This association between philosophy and psychology remains a prominent feature of discourse in both fields, and was especially prevalent as each discipline was trying to ascertain what it included. A lot of this reconfiguring happened during Ladd-Franklin’s professional life, while she worked to straddle the continually dissociating areas.

Peirce often framed logic within the context of a general theory of meaning. Done right, it provided methods for distinguishing concepts and ideas. Though they may use similar or even identical processes, he saw logic and mathematics as distinct because logic is a practical science, while mathematics focused on the theoretical.⁹ Ladd-Franklin concurred with this view in an 1889 gloss on the topic. “Whether a thing is mathematics or not,” she wrote, “depends on its subject matter, not upon the accidents of its dress.” She further explained that “it is merely a question of convenience of nomenclature whether one defines mathematics to be that branch of logic which deals with measurable quantities, or logic to be that branch of mathematics that deals only with objects with masses and their qualities, without regard to their number or size.”¹⁰

⁶ Fisch, “Peirce’s General Theory of Signs,” 33.

⁷ Francesco Belluci, “Logic, Psychology, and Apperception: Charles S. Peirce and Johann F. Herbart,” *Journal of the History of Ideas*, 76(2015), 69.

⁸ Charles Sanders Peirce, “The Logic of Science,” Harvard 1965. Cited in Fisch, “Peirce’s General Theory of Signs,” 33.

⁹ Claudine Tiercelin, “Was Peirce a Genuine Anti-Psychologist in Logic?” *European Journal of Pragmatism and American Philosophy*, 9(2017).

¹⁰ Ladd-Franklin, “Symbolic Logic,” 544.

Peirce viewed logic as using mathematical tools to conduct philosophical meaning-based explorations. Meaning cannot be confined to a single discipline, and neither could logic.

Historically, though, the dominant view held that meaning did derive from a single source: religion. Consequently, religious priorities shaped the first century of American higher education. The big questions later relegated more exclusively to philosophy—the meaning and nature of existence, free will, ethics, the sources of truth and knowledge—were considered to be in the domain of clergymen. This does not mean religion guided all study of philosophy until that point, but this tendency was evident in most American universities until the late nineteenth century. Philosophy and philosophical methods developed separately from theology, but in the university they remained closely linked and at times indistinguishable sub-disciplines of the study of religion. In the period following the Civil War, however, universities began to undergo major reorganization which led to and allowed for reconstituting disciplines into their more discrete, specialized parts.

Historians attribute some of these changes to developments beginning in European universities, especially in Germany. The development of science and the scientific method and the expansion of academic scholarship led to these changes, as did standardizing methods of analysis appropriate to different fields. As American scholars visited German universities, they brought back their experiences in research seminars and laboratories with a desire for new precision in defining areas of study. German universities rearranged in the 1850s, and their American counterparts followed with a ten-year lag and different innovations. In 1869, Harvard president Charles Eliot reintroduced an elective system in place of the previously established set curriculum of required courses. This approach, which spread to other schools, helped to assert the equal value of all fields of learning, which helped burgeoning fields claim a place in the

offerings.¹¹ Eliot, though a practicing Christian, supported the establishment of philosophy as a field separate from religion. He declared that “philosophical subjects should never be taught with authority,” as the often monolithic view of the clergy who had previously controlled philosophical debates limited true academic inquiry.¹² Johns Hopkins University, which first opened in 1876, furthered the reach of specialization by standardizing requirements for a graduate degree in 1877, with graduate studies consisting of two years of formal studies in one main subject and one auxiliary field.¹³

With specialization came power. These new trends provided academics greater opportunities to claim their areas of expertise and dig deeply, investigating the details of their chosen areas. The institutionalization of scholarship allowed scholars to lay claim to university resources to advance their studies. Accordingly, they faced increasing responsibilities to their universities and newly organized intellectual communities. They were expected to make specific contributions to the advancements of their given fields in the name of their universities. Postbellum academics wrote more, taught more, and convened more with peers and students than did their less specialized and largely amateur predecessors. This further elevated the role of secular academics over the clergy. Their identification with far-reaching specialized interests provided universities with the authority previously granted to churches. Specialization also allowed university scholars to turn their attention to address fundamental problems, because with newfound institutionalized support, practical considerations now had less influence on choice of

¹¹ Alexandra Oleson and John Voss, *The Organization of Knowledge in Modern America, 1860-1920* (Baltimore: Johns Hopkins University Press, 1979), x.

¹² Bruce Kuklick, *The Rise of American Philosophy: Cambridge, Massachusetts, 1860-1930* (New Haven: Yale University Press, 1977), 133.

¹³ John Higham, “The Matrix of Specialization” in Alexandra Oleson and John Voss, ed., *The Organization of Knowledge in Modern America, 1860-1920* (Baltimore: Johns Hopkins University Press, 1979), 11.

study. As explained by the social scientist and public intellectual Edward Shils, “at a time of faltering theological conviction, the university scholar or scientist assumed the rule of an earnest seeker after fundamental truth.”^{14,15}

The convergence of rapid advancement in the sciences and the increased communication between specialized scholars during this time period led to a desire to create consensus. Universities established disciplines such as anthropology, economics, and political science as distinct from the hazy traditions of government, morality, and general philosophy. Scholars from different institutions met to determine the guiding principles of their fields. They sought to identify the accepted methodology and problems of these newly distinct areas. Thus, they began to see philosophy as separate from religion, with only philosophers doing philosophy.

Before this rush to specialization, scholars developed the tools they needed to pursue their intellectual work as circumstances demanded and their abilities allowed. The logicians of the tradition Ladd-Franklin claims as the intellectual heritage of *On the Algebra of Logic*—Boole, Jevons, Schröder, MacColl and Peirce—however, all combined rigorous mathematical development with considerations of their philosophical implications. Historians consider Boole to have begun a revolution of logic by being the first to prominently apply methods of algebra to the field. In Boole’s dense and technical 1847 book on logic, he mentions Aristotle and his syllogisms more than his mathematical contemporaries might have in their own works. And, perhaps consequently, though Boolean algebras came to prove important and useful to theoretical and applied mathematical fields, mathematicians did not immediately treat his work

¹⁴ Edward Shils, “The Order of Learning in the United States: The Ascendancy of the University” in Alexandra Oleson and John Voss, ed., *The Organization of Knowledge in Modern America, 1860-1920* (Baltimore: Johns Hopkins University Press, 1979), 21.

¹⁵ Fittingly, Shils himself was once praised as being a metaphorical “cardinal of the sociological church.” Quoted in Martin Bulmer, “Edward Shils as a Sociologist,” *Minerva* 34(1996), 7.

with much interest. Other logicians recognized Boole because they saw, as described in *The Development of Modern Logic*, “in writing a book on logic, he was doing philosophy.”¹⁶ The next logician Ladd-Franklin cites, William Jevons, was primarily an economist, most known for his book *A General Mathematical Theory of Political Economy*, in which he argued that since economics deals with quantities, it is inherently a mathematical science.¹⁷ In *Pure Logic*, which he published in 1864, he created a system based on Boole’s in which he sought to derive all of mathematics from logic, emphasizing the close relation between the two fields.¹⁸ The other cited logicians did not so much precede Ladd-Franklin as they worked in conversation with her and Peirce. Ernst Schröder’s 1877 *Der Operationskreis des Logikkalküls* described and explained Boole’s ideas and included Peirce’s work on logical quantification. In turn, Peirce used Schröder’s text while teaching at Johns Hopkins. MacColl, too, recognized the distinction and overlaps between the fields. His 1906 *Symbolic Logic and its Applications* included in its introduction instructions for readers who were mathematicians as to which chapters they would find most interesting, and which they would want to skip.^{19,20}

These logicians, especially Peirce, were not just interested in developing logic for logic’s sake. They intended logic to be used to solve philosophical problems and hoped to employ the Boolean method to standardize and simplify the process. Philosophers were meant to take propositions in plain language and translate them into a logical language using well-defined

¹⁶Volker Peckhaus, “The Mathematical Origins of Nineteenth Century Logic” in Leila Haaparanta, ed., *The Development of Modern Logic* (New York: Oxford University Press, 2009), 163.

¹⁷ William Stanley Jevons, “Brief Account of a General Mathematical Theory of Political Economy,” *Journal of the Royal Statistical Society, London* 29(1866), 282-287.

¹⁸ Bert Mosselmans, “William Stanley Jevons”, in Edward N. Zalta, ed., *The Stanford Encyclopedia of Philosophy*, 2017.

¹⁹ Hugh MacColl, *Symbolic Logic and its Applications* (London: Longmans and Green, 1906), v.

²⁰ This is not a unique phenomenon. Modern textbooks on Boolean logic, including those used in current courses at Columbia University, often contain similar instructions. See, for example, Steven Givant and Paul Halmos, *Introduction to Boolean Algebras* (New York: Springer, 2009), xii.

techniques. Then, they would apply algebraic methods to combine, solve, or simplify the propositions as need be. They could then apply the same techniques in reverse to translate the algebraic propositions back into plain language claims. This proposed methodology mirrored approaches in the natural sciences—gather data, input them into accepted formulas, and then analyze the conclusion. The philosophers in this modern logic tradition thereby hoped to create a clear way to thoroughly analyze philosophical problems.

Boole's method, however, did not completely meet the needs of those who wished to employ it. This newly renewed tradition of mathematical logic provided Ladd-Franklin and others the opportunity to make real contributions. The tool of logic needed to be fine-tuned, as this algebra had to generate solutions understandable as sensible within their philosophical domains. What could be defined as sensible, of course, can be and was debated. Astronomers may have been using observations of the sky and planetary bodies to develop the math which allowed them to make predictions. Often, this math could be tested on its accuracy using empirical observations to confirm the theoretical predictions. Not so for philosophy, which provides many fewer avenues for empirical confirmation. Ladd-Franklin believed she could circumvent this problem and finally allow the broader intellectual community to consider philosophy as one of the sciences. To understand her early contributions and the methods she thought philosophers should employ, it is necessary to explain the basic theory and methodology of Boole's original algebras she adapts in her first paper.

In elementary algebra, variables, usually expressed as letters (such as a , b , c , x , y) represent numbers—that is, the values of the variables are numbers, which can be picked out from a given number line. In Boolean algebra, the variables represent truth values—they stand in for either 'true' or 'false,' values often referred to as Booleans. Booleans can be represented in

any pair of elements. Modern logicians often represent these elements in the set $\{T, F\}$; applied mathematics and other sciences often make use of the binary $\{0, 1\}$. As in elementary algebra, Boolean algebra employs a set of operators. The primary operators (and for some, the only operators) in a basic Boolean algebra are listed here, along with their accepted modern symbolic representations.

Symbol	Function	English
\neg	negation	not
\wedge	conjunction	and
\vee	disjunction	or
\rightarrow	conditional	if, then

These operators combine variables to yield different truth values, following a strictly prescribed set of rules. Thus, for example, the negation of a variable valued ‘true’ yields the result of ‘false,’ and the conjunction of two true variables yields ‘true.’ Simply put, the goal of algebraic logic is to generate the truth values of philosophical propositions. The techniques must be specific to produce accurate, analyzable results.

Doing philosophy through algebra presents the advantage of using logical translations that collapse propositions which seem different in plain language into symbols that reveal their equivalences. But sometimes, this collapse may go too far in removing the original intent of the speaker. To use an example provided in Ladd-Franklin’s original paper, the propositions “no men are mortal” and “there are no mortal men” are logically equivalent statements. They both yield true in a universe in which all men are immortal; false in a universe like our own, in which there exists at least one man who falls victim to the apparently unyielding talons of death. But though these propositions will always be truth-equivalent, a speaker in plain language understands they contain subtle differences. “No men are mortal” is a statement about men—in

philosophical terms, it is a description of a particular. “There are no mortal men,” however, is a statement about the domain or universe of discourse—a description of a universal.²¹ Boole does not provide any symbols in the original formulation of his algebra to allow the logician to distinguish between the particular and the universal. Ladd-Franklin’s algebra makes this distinction. She thought that the difference in concepts she used her signs to convey must also be explicit in the symbols themselves. In logic, the symbol “transcends the limitations of ordinary language and ignores rhetorical and psychological distinctions of no logical import.”²² These symbols—the ones which indicate how a subject is, whether they refer to a particular or universal—are types of copulas. Ladd-Franklin’s logic expands her usage of the copula by assigning different symbols to indicate when the speaker of a statement discusses a particular or a universal. Emblematic of a student of the semiotic-obsessed Peirce, she insisted that the shapes and interactions of the symbols themselves be designed with intention and for utility. She treats the way they look on the page and interact with each other as a matter of serious consideration. Her logic does not just have to work, it must work well. As the calculator of meaning, every bit must be meaningful, and not just look good on a page. Following Peirce’s lead, the symbols relate to each other as the meanings they represent do—transformation and calculation between them are visible in their shapes. Ladd-Franklin’s copulas and new symbols helped clarify the difference between the subject and the predicate of the statement. Her language did not just express propositions, but also told the listener something more about what those propositions discussed.

²¹ This claim is actually a complicated one, metaphysically. Can a statement about “no men” really be considered a statement about men? Is it, perhaps, just a reference to the concept of men? This, however, is a question of interpretation, and of no consequence to the logic itself.

²² Eugene Shen, “The Ladd-Franklin Formula in Logic: The Antilogism,” *Mind* 36(1927), 55.

Aristotle's logical system contained four distinct statements meant to express all forms of relations with universal subjects. Philosophers generally express these statements in pairs, with capital letters representing propositions: those with universal predicates, "All a 's are b 's" with its denial "No a 's are b 's"; and those with particular predicates, "Some a 's are b 's" with its denial "Some a 's are not b 's." These statements became the center of major logical expression and expansion and remain so today.

All a 's are b .	$a < b$	$a - b = 0$	<i>Aristotle's categorical statements as expressed using algebra.</i> ²³
No a 's are b .	$a < -b$	$ab = 0$	
Some a 's are b .	$(a < -b)'$	$ab \neq 0$	
Some a 's are not b .	$(a < b)'$	$a - b \neq 0$.	

But Aristotle's statements, explained logician Eugene Shen in a 1927 article in the journal *Mind*, had left logic "practically in the primitive condition." He says Ladd-Franklin's developments "should have long superseded" Aristotle's four propositions.²⁴ To include particular statements—to make the distinction between a universe of mortal men and the mortal men who are qualified by their existence in the universe—Ladd-Franklin's logic uses eight propositions. The additional four are " a includes all b ," " a does not include all b ," "there is nothing besides a and b ," and "there is something besides a and b "²⁵ The eight statements and their symbols are listed here.

²³ I. Susan Russinoff, "The Syllogism's Final Solution," *The Bulletin of Symbolic Logic*, 5(1999), 457.

²⁴ Shen, "The Ladd-Franklin Formula," 54.

²⁵ Ladd, "On the Algebra of Logic," 26.

{	a.	$p \overline{\vee} q$	No p is q .
	b.	$p \overline{\forall} q$	All but p is q .
	c.	$p \leq q$	All p is q .
	d.	$p < q$	None but p is q .
{	a.	$p \vee q$	Some p is q .
	β .	$p \forall q$	Not all but p is q .
	γ .	$p \leq q$	Not all p is q .
	δ .	$p < q$	Some besides p is q .

Ladd-Franklin's eight logical propositions.

For Ladd-Franklin and her adapters, this expansion of the logical language allowed the algebra of logic to function with greater accuracy. The restrictions of using only the original four propositions limited the entire domain of discourse accessible to philosophers and their associates. More specific algebra meant better reasoning and better philosophy, and, if successful, could provide the tools for the advancement of the entire discipline as well as the entire project of human philosophical thought. This expansion provided the basis for the antilogism, Ladd-Franklin's other novel point in this paper and a central tenet of her approach to logic and philosophical discourse that she was to hold throughout the rest of her career.

Chapter 3:

“I Am Somebody”: Antilogisms and the Resetting of Logical Discourse

“When the first mathematical, logical and natural uniformities, the first LAWS, were discovered, men were so carried away by the clearness, beauty and simplification that resulted, that they believed themselves to have deciphered authentically the eternal thoughts of the Almighty. His mind also thundered and reverberated in syllogisms.”—William James, “What Pragmatism Means,” 1907 [29].

In 1928, while she was teaching at Columbia just three years before her death, Ladd-Franklin published a short piece in the philosophy journal *Mind*. In this piece, just three pages in the “Notes” section in the back of the journal, she discusses, for the final time in print, her work in logic. She begins in a fashion typical of many other pieces she published throughout her career: by asserting ownership of her own ideas. She accuses British philosopher William Ernest Johnson of using her work, unattributed, in his book on logic that he had published six years previously, in 1922. “He has robbed me,” she writes, “of my beautiful word ‘antilogism’.” The antilogism, she explains, “is the basic feature of my theory of deductive reasoning.” She demanded full credit for “the word and the thing.”¹

Her claim is not overblown—Ladd-Franklin was the originator of both the concept and the name. She first introduced the preliminary basis of the antilogism in “On the Algebra of Logic” in 1883. She had not yet coined the “beautiful word,” and instead refers to “the argument of inconsistency.”² There, after a lengthy discussion of her proposed formulations of logical

¹ Christine Ladd-Franklin, “The Antilogism,” *Mind* 37(1928), 532-534.

² Ladd-Franklin, “On the Algebra of Logic,” 40.

propositions, appropriate symbolization, and methods of computation, she turns to the discussion of the syllogism. Aristotle’s syllogistic forms were meant to encompass all forms of logical argument. Aristotle’s forms involved arguments made of categorical statements. As logician I. Susan Russinoff explains, however, “the problem that Aristotle posed and attempted to solve is to give a general characterization of the valid syllogisms. This is the problem that Ladd-Franklin finally solved in the late nineteenth century.”³ She wrote that the argument of inconsistency—the antilogism—is “the single form to which all the ninety-six valid syllogisms (both universal and particular) may be reduced.”^{4,5} The syllogism, as explained above, classically consists of a set of three categorical statements: two premises and one conclusion. For a syllogism to be valid, the conclusion must necessarily follow from the premises. Syllogisms can be constructed in different forms, with different types of propositions and argument types.⁶ Ladd-Franklin provides the formula for inconsistencies as

$$(a \bar{\vee} b)(c \bar{\vee} d) \bar{\vee} (ac \vee b + d).$$

This is read as “if no a is b and no c is d , then it cannot be the case that both a and c are either b or d .”⁷ All syllogisms can be tested for validity by reducing them to this form. The way to do this, Ladd-Franklin explains, is simple, and per the modus operandi of algebraic logic, systematic. One must “take the contradictory of the conclusion, and see that universal propositions are expressed with a negative copula and particular propositions with an affirmative

³Russinoff, “The Syllogism’s Final Solution,” 452.

⁴Ladd-Franklin, “On the Algebra of Logic,” 40.

⁵This count of 96 valid syllogisms does not have universal concurrence, but it is the number Ladd-Franklin has determined and uses in multiple places.

⁶Medieval logicians assigned fun mnemonic names to these forms. My favorite is named “Barbara.” Ladd-Franklin’s system gets rid of the need for these names, which is good for logic, but bad for those who enjoy referring to sets of propositions as they would people.

⁷Russinoff, “The Syllogism’s Final Solution,” 461.

copula. If two of the propositions are universal and the other is particular, and if that term only which is common to the two universal propositions has unlike signs, then, and only then, is the syllogism valid.”⁸ This method can best be explained with an example. Take the following propositions

Only Greeks are brave

All Spartans are Greeks

Therefore, all Spartans are brave.

It is probably clear that this is not a valid syllogism. Just because it is only Greeks who are brave does not mean that all who are Greeks are brave. Syllogisms in this form tend to be easily parsable. Ladd-Franklin concedes that “it is impossible not to admit the great gift to the powers of the common mind to have devised a method by which one can sit down before half a dozen premises of this kind and know just how to go to work and pick out with absolute certainty everything that is said about anything.”⁹ But relying on these powers can lead to less efficient or even faulty problem solving. Instead, the Ladd-Franklin method instructs the logician to convert those propositions into the following:

Non-Greeks are-not brave

Spartans are-not non-Greeks

Some Spartans are not-brave.

The conclusion is contradicted, the universal propositions are expressed with the “are-not” copula. The universal term “brave” appears with unlike signs, the particular “Greeks” with like signs. Without any attempt to understand the propositions, the argument of inconsistency allows—demands—any analyzer declare this an invalid syllogism.

⁸ Ladd-Franklin, “On the Algebra of Logic,” 41.

⁹ Christine Ladd-Franklin, “Symbolic Logic, 544.

Ladd-Franklin introduces a better name for this inconsistent triad in 1901, in a short article for the journal *Science* titled “The Reduction to Absurdity of the Ordinary Treatment of the Syllogism.” There she explains that “the traditional treatment of the syllogism errs both in by redundancy and insufficiency.” She declares that the “canonical form” of the syllogism should therefore be

no a is b

no c is non- b

and some a is c .

These propositions, taken as a whole, are inconsistent, and should therefore be called “the Inconsistency, or the Incompatibility, or, perhaps, the Antilogism.”¹⁰

At this point in her career, Ladd-Franklin had already traveled to Germany and published serious work in psychology. Her success in that field, however, did not halt her efforts to clarify and promote her theories in logic. Analysis via antilogism, she claimed, allowed for a major reduction in confusion and error. She emphatically describes the source of this type of error in a later paper, published in *The Philosophical Review* in 1912: “From ‘no dancing is moral’ it does not follow that ‘nothing which is not dancing is immoral’ and it almost makes one dizzy to try to believe that it does. But what it would have meant in the long history of bad reasoning in this world, if we had always been warned against Wrong Conversion by a feeling of dizziness, as we literally should be, if we tried to commit it in terms of the negative copula!”¹¹ Here, she argues that the world is too big and too complex to rely on intellect alone. The job of the logician is to make systems that replace dizziness and allow us to overcome the limits of human reasoning.

¹⁰ Christine Ladd-Franklin, “The Reduction to Absurdity of the Ordinary Treatment of the Syllogism,” *Science*, 13(1901), 574-575.

¹¹ Christine Ladd-Franklin, “Implication and Existence in Logic,” *The Philosophical Review*, 21(1912), 646.

The syllogism is not enough. “Antilogism,” she explains in the same paper is “a term which suggests connection with, and antitheticalness to, the ordinary syllogism.”¹²

Though the braveness of Spartans and the mortality of men are classic and oft used examples of syllogism, Ladd-Franklin’s “favorite illustration” of the antilogism employed a different subject matter. It goes like this:

A mother, reproving her child at the table, said, “Nobody eats soup with a fork, Emily,” and Emily replied, “But I do, and I am somebody.”¹³

Ladd-Franklin used the example of Emily and her mother in most of her papers on the antilogism, as well as in private correspondence.¹⁴ It allowed her to illustrate just how natural the form was to normal human conversation. Emily’s opposition to her mother “said in effect: Here is an inconsistent triad of statements, and since mine are patently true, yours must be certainly false.” The antilogism, she explained, is “the natural, the inevitable, form of reasoning in cases of controversy—rebuttal.”¹⁵

Ladd-Franklin, at least, certainly found the rebuttal to be a natural and inevitable form of conversation. Her work within and outside of philosophy often took the form of pushing against accepted norms. In some senses, this is unremarkable. Scientific advancements and new hypotheses often take the form of refuting what was previously accepted, and Ladd-Franklin spent much of her career as an experimental psychologist. Her rebuttals in the following examples, however, in contexts that might appear to have nothing to with the algebra of logic, help illustrate the form in more casual practice.

¹² Ladd-Franklin, “Implication and Existence,” 648.

¹³ Ladd-Franklin, “Implication and Existence,” 648.

¹⁴ See, for example, Christine Ladd-Franklin, n.d. Office of Alumni Services, Johns Hopkins University Archival Collections, Baltimore.

¹⁵ Ladd-Franklin, “Implication and Existence,” 649.

In this first example, Ladd-Franklin employs this form of argument to claim standing. Due to the specialization of academia at the turn of the century, intellectuals and academics turned their focus to more and more specific subfields. They created groups and associations to share their research and expertise. One such scientific society was known as the Experimentalists. This group of experimental psychologists was formed in 1904 by the psychologist Edward Titchener of Cornell University. They met every year to present papers and discuss developments in their field. These meetings were strictly restricted to men. In *A History of Experimental Psychology*, Edward Boring recounts stories of qualified women listening in on the group's meetings through the cracked door of an adjoining room or even from underneath a conference table.^{16,17} Ladd-Franklin, though, was not willing to hide. In 1912, she wrote to Titchener, requesting to present a recently published paper at that spring's meeting at Clark University. Titchener refused her request. The meeting would take place in a room full of cigarette smoke and male energy, he explained, by way of excuse, that would not be proper or comfortable for an attending woman. Ladd-Franklin responded by channeling the young, fictitious Emily. "I for one," she wrote back, "always smoke when I am in fashionable society."¹⁸

In other words,

A psychologist, condemning a woman at the table, said, "Women don't smoke,

Christine," and Christine replied, "But I do and I am a woman."

Of course, this was not an argument about whether women could bear to smoke—it was about their ability to publicly participate in academia. Ladd-Franklin argues that women can bear the scrutiny of their intellectual peers. She challenges Titchener by letting him know she can see

¹⁶ Cited in Scarborough and Furumoto, *Untold Stories*, 118.

¹⁷ A comparison to Hillel, who is said to have learned from the roof of the House of Study, is unavoidable. See Babylonian Talmud, Yoma 35b.

¹⁸ Scarborough and Furumoto, *Untold Stories*, 125.

through his ruse of chauvinist gentility, and that she won't wait around for him to get over his prejudices. The antilogism picks apart the faulty argument and demands recourse. I am somebody, she says, recognize my abilities and acknowledge my humanity.

Women were never invited to join the Experimentalists, but they were eventually allowed to formally present their scholarly findings to their colleagues in similar forums. But not everything Ladd-Franklin supported has stood the test of time. This next example of the antilogism in action appears within a discussion about Esperanto, a proposed international language. One such effort was instituting the language of Esperanto. Esperanto was created by a Polish linguist near the end of the nineteenth century, in the hope that it would act as an easy-to-learn shared international language. Though its popularity has mostly died out, it did gain some early support from philosophers and mathematicians. Ladd-Franklin attended the 1908 meeting of the Third International Congress of Philosophy in Heidelberg, Germany. At that meeting, the French logician Louis Couturat spoke in favor of adopting the language for international philosophical discussions. Mathematician Giuseppe Peano, who was also at the conference, added that "there were many connections between logic and the problem of an international language."¹⁹ Ladd-Franklin agreed, and published an opinion piece in the *New York Times* supporting her view. She employs the antilogism to make a minor point in this article. "It is both illogical and impertinent for the inhabitants of the United States to seize upon the name Americans for themselves," she wrote. "Anyone who is a resident of any part of North or South America is an American." Once again, for the sake of illustration, this argument in a simplified Emily form may read

"American" refers to a citizen of the United States

¹⁹ Hubert Kennedy, *Peano* (Springer: New York, 1980), 123.

But I am not a citizen of the United States, said the Brazilian,
and I am an American too.

Ladd-Franklin's argument, in which she suggests that someone from the United States should be referred to using the Esperantian name, "Usonian," seems comical. Her advocacy also extended beyond Usonia, as she remained in contact with Couturat, even suggesting the Esperanto words for "mother" and "woman."²⁰ But her point still stands to demonstrate a casual use of the antilogism in action.

The antilogism did not succeed in fully replacing the syllogism and methods for testing their validity, but it has remained in use. Logicians such as Willard Quine expanded on the antilogism throughout the second half of the twentieth century, and it has been cited in discussions of relevance logics even more recently.^{21,22} The form of the antilogism itself is indicative of more than a solution to a problem in syllogistics. The antilogism, as it was first introduced in "On the Algebra of Logic," begins to reveal Ladd-Franklin's overarching theories of logic, philosophy, and discourse. These theories are best expressed in her most significant non-logic-based proposal in philosophy: the Doctrine of Histurgy.

²⁰ Christine Ladd-Franklin, "Usonia is Logical" *New York Times* (1915, July 12), 6.

²¹ Willard Van Orman Quine, *Methods of Logic* (Henry Holt and Company: New York, 1950).

²² For example, see Jean Norman and Richard Silvan, *Directions in Relevant Logic* (Kluwer Academic Publications: Dordrecht, 1989), 4.

Chapter 4

A New Tree of Knowledge: Epistemology and the Doctrine of History

“We will the eternal. We define the eternal. And this we do whenever we talk of what we call genuine facts, or actualities, or of the historical content of human experience, or of the physical world that our sciences investigate.”—Josiah Royce, “The Problem of Truth in Light of Recent Discussion,” 1908 [83].

The focus of the 1908 International Congress of Philosophy in Heidelberg mentioned in the last chapter was not Esperanto, but that very proposition is representative of the underlying purpose of the Congress’s convening: to communicate. The Congress presented an opportunity for the philosophers of the day to share, compare, and defend their ideas with other experts. Conferences of this sort were a growth of the academic specialization that universities enforced and aimed, at least partially, to set the standards of the field. Ladd-Franklin attended this conference and presented a paper that attacked the core of this claim. Her talk was titled “Epistemology for the Logician.”¹

Epistemology is the branch of philosophy that deals with the meaning, source, and methods of knowledge, and thus can be construed as setting a basis for all other forms of philosophical inquiry. Ladd-Franklin’s paper made little splash but was forceful nonetheless. In it, she attacked the organization of the entire field of philosophy from the viewpoint of a logician deeply established in that same field. Once again, her paper was made of two major points. The first part of the paper focuses on the method of epistemology, and how it should be approached by the philosophical community. In the second part, she presents some preliminary ideas of what conclusions this approach would reach. These proposals, considered within their historical and

¹ Christine Ladd-Franklin, “Epistemology for the Logician,” in Elsenhans, ed., *Internationalen Kongress für Philosophie*, 664-670.

intellectual contexts, provide insight into the reigning questions of intellectuals and how the international academic community considered their role in the world and the future.

The official records of the conference list Ladd-Franklin as a faculty member of Johns Hopkins.² Her primary association was still in Baltimore at that point, but she may only be considered a member of the faculty in the most peripheral of ways. Her appointment was as an unsalaried lecturer and was limited to one course a semester.³ Though her contributions to philosophy, then, remained more outside of the classroom and the dominant institution-based philosophical community than within, her argument reveals the perspective of someone nevertheless very committed to the organizational philosophy of the field. Her successful forays of the previous years into psychology are apparent as well, as she begins by discussing the scientific community that often intersected with the philosophic one.

She offers a comparison between the development of the sciences and the development of philosophy. “It is an old reproach in philosophy,” she says, “that nothing remains as established, accepted, doctrine for future generations to build upon.” New philosophers are welcome to renew and rehash ancient arguments, without ever coming to satisfying conclusions. “The hallmark of science,” however, “is that its acquisitions are cumulative from generation to generation.” Because of this stability and means for growth, “its results command assent, and its consequences demand respect.” In light of this deficiency, she proposes that critics might be correct in writing philosophy off as a field of serious consequence. Philosophy, she claimed, was too disorganized, too unsystematic. “In other branches of learning,” she continued, “absurd hypothesis and creed are quickly weeded out by ruthless criticism.” But in philosophy, especially in the grounding questions of metaphysics, “no matter how feeble a doctrine may be, no amount

² Elsenhans, *Internationalen Kongress für Philosophie*, 664.

³ Johnson, “Christine Ladd-Franklin.”

of criticism can lay its head low forever.” She acknowledges and clarifies that science does not make a business of determining absolute truths without revision, but that it represents “at a given time, the best result of the combined effort of all scientists.” Ladd-Franklin determined, “in the present view of the logician,” that something had to be done to save philosophy from its overworked and under-established self. Otherwise, “shall we be forced to admit...that metaphysics, in a word, is poetry?”⁴

In Ladd-Franklin’s understanding, the process of reaching a conclusion of any sort is intrinsically tied to both the method of inquiry and the factors that deem a solution acceptable. Epistemology, then, must conform to truth valuation. What we know is mixed up in the ways in which we know those things, and philosophers had not come to any consensus in either regard.

Ladd-Franklin was not the only one to focus on the disparate theories of knowledge at the Heidelberg conference. Josiah Royce of Harvard University, the philosopher who had referred to Ladd-Franklin’s first paper on logic as the “crowning achievement” of the field, presented the opening address of the conference. His title: “The Nature of Truth in Light of Recent Discussion.”⁵ As Royce demonstrated, truth certainly was a frequent and heated topic of discussion among philosophers at the time. In this paper, Royce characterizes the leading positions, and then offers his own theory on the matter. His clear delineation of these theories demonstrates the parameters of the debate while also contextualizing Ladd-Franklin’s criticisms and proposals.

Royce provides an intellectual historical context for his discussion. He says that truth, as a topic of philosophy, falls in and out of mainstream discourse. Between 1830 and 1870, truth

⁴ Ladd-Franklin, “Epistemology for the Logician,” 664-666.

⁵ Josiah Royce, “The Problem of Truth in Light of Recent Discussion,” in Theodor Elsenhans, ed., *Bericht über den III. Internationalen Kongress für Philosophie zu Heidelberg 1. bis 5. September 1908* (Carl Winter: Heidelberg, 1909).

was neglected in favor of metaphysics, ethics, and theology. 1870, though, marked a change in philosophical opinion. At that point, the fields of psychology and logic (that ever-recurring pair) gained prominence in America. At the same time, science was expanding and rapidly adjusting course in response to the revolution of evolution and genetics that began in the 1860s.

Meanwhile, English philosophers turned towards Idealism, which considers objects of thought to be dependent on the activity of the mind, and the French focused on philosophy of science. All of these required a basis of a sound theory of truth. By naming these groups, Royce refers to the general intellectual upheaval that Ladd-Franklin tapped into. New methods of logic, theories of science, and considerations of self at the turn of the century thrust philosophy into “the storm and stress of a re-examination of the whole problem of truth.”⁶

Though Royce did not totally avoid philosophical jargon in his talk, he tried to focus on the meanings and motivations behind different theories of truth, which allowed him to group them by type and not just refer to them by name. Adherents of these different theories were all in attendance, and he gave full consideration of their positions before describing his own.

The first motivation he described is tied to study of the evolutionary process and history of institutions. In this view, human opinions, judgments, and ideas are the result of attempting to adapt to the demands of the natural world. Truth has some value, but not more than “the value which any natural organic function possesses.”⁷ True assertions are those that best accomplish biological functions. This truth is “relative as it is instrumental, as human as it is useful.”⁸ As such, Instrumentalists and Pragmatists generally assert this notion of truth. Both views hold, with Instrumentalism applying the theory mostly to science and Pragmatism widening the perspective

⁶ Royce, “The Problem of Truth,” 64.

⁷ Ibid, 66.

⁸ Ibid, 67.

to the entire universe of ideas, that theories are to be assessed not for some inherent truthiness, but for their ability to generate confirmable predictions. To varying degrees, these approaches placed prime importance on clear, verifiable methodology. Ladd-Franklin patently holds this assertion in all her work. Her teacher, Charles Peirce, was the progenitor of Pragmatism, and her correspondent and mentor William James became one of the definitive proponents of the movement. She does not explicitly align with either of these traditions (in fact, as will be demonstrated, she quite obstinately disassociates herself from them), but Royce's choices when describing the main motivations behind prominent theories of truth exemplify the intellectual environment in which Ladd-Franklin came to and expounded on her own conclusions. Advancements in science and mathematical methods of statistics and probability presented far-reaching consequences on the entire notion of human thought.

The second category of truth theories, explains Royce, "strongly contrasts with the first," yet even their proponents get them confused. Forms of Individualism and Idealism exhibit this second motivation by essentially allowing for each being to find their own truth and apply it as they see it. Sometimes, this leads to Irrationalism, a movement that pushes beyond the rational limits of traditional truth and claims that more remains to understand and incorporate. As such, we can see that "intelligence, after all, is but a single and very narrow function of our nature, which must not be allowed to supersede, or even to dominate the rest of our complex and essentially obscure, if fascinating, life."⁹ This approach incorporates the same realities and expansions in scientific discoveries and philosophical thoughts as the first one did, and then heads in the opposite direction. Practitioners of the natural sciences at the turn of the century had just begun to understand how little they knew about the physical world. These philosophers, in

⁹ Ibid, 68.

response, developed an ideology that made similar distancing claims about their abilities to identify, through intellectual work and logical development alone, what it means to be known, existent, or true in this unknowable universe.

The third and final motivation Royce recounts is again of prime importance to understanding Ladd-Franklin's place in the development of philosophical thought. He shies away from naming it or attributing it to any specific movements. His hesitation is itself indicative of the charged role it played in philosophy. This theory of truth is that of logic. This philosophy, he explains, may be familiar to practitioners of pure mathematics and metageometry than to metaphysicists, but stands as a comprehensive mode of truth discernment nonetheless. These new methods of rigid mathematical-logical proof "have meant clearness, self-possession, and a raising of scientific conscience to higher levels."¹⁰

Despite his high commendations, Royce does not himself adhere to this type of truth formulation. Instead, he tries to describe his own theory, which he names Absolute Pragmatism, and claims that it somehow combines the workable parts of the other motivations into "the genuine theory of truth."¹¹ But Royce's ultimate argument, fascinating as it may be, is not the matter of discussion here. As this was the main presentation of that day, other attendees were given an opportunity to discuss and respond to the points he made, the most significant of which were published alongside the original piece. Ferdinand Canning Scott Schiller of Oxford University, who philosophers generally ascribe a position corresponding to James's Pragmatism, "could not quite gather what Prof. R's absolute truth really was."¹² Despite this and similar

¹⁰ Ibid, 72.

¹¹ Ibid, 76.

¹² Elsenhans, *Internationalen Kongress für Philosophie*, 92.

responses, Royce's presentation was nevertheless "listened to with pleasure, and was warmly applauded" by the conferencing philosophers.¹³

After this first speech, attendees split off by topic. Sectional specialization undermined the efforts of those who wished to hear talks from across the spectrum of philosophical topics. This "unavoidable, but unfortunate, division into sections made it impossible to hear some of the discussions one would most have wished to hear."¹⁴ No record of the reaction to Ladd-Franklin's talk exists. Her views, then, were not inflammatory enough as to warrant backlash, but were also not considered sufficiently laudable to incur special mention. One description classifies this piece with the Pragmatists, another more generally with Epistemology; the Congress records group her with speakers on logic.^{15,16} Her epistemology and the Doctrine of History did not make much of an impact on the philosophic community. But they are worth historical analysis.

Her first proposition consisted of a means for philosophy to assert itself among the sciences. Royce was content with describing what he saw as the prominent positions on truth, and then describing his own as emerging among them. Ladd-Franklin focused on a renewed metaphilosophy, and only then situated her ideas within a specified range of topics and methodology. In this sense, her short paper does more than state her opinion as one of the many shared within the congress and without. Her philosophy, with sources in the same movements and intellectual developments as her peers, demands that attention be paid to both the content and the packaging of any given proposition.

¹³ George Stuart Fullerton, "The Meeting of the Third International Congress of Philosophy, at Heidelberg, August 31 to September 5, 1908," *The Journal of Philosophy, Psychology, and Scientific Methods* 5(1908), 573.

¹⁴ Fullerton, "The Meeting of the Third International Congress of Philosophy," 576.

¹⁵ Jaime Nubiola, "Pragmatism on the European Scene," *Rivista di Storia della Filosofia*, 3(2017), 386.

¹⁶ Fullerton, "The Meeting of the Third International Congress of Philosophy," 576.

Convening in Heidelberg or elsewhere once a year to share thoughts was not enough for Ladd-Franklin. For philosophy to be considered legitimate, it had to become one of the sciences. Science required consensus, and a spirit of forward progress, with hypotheses and accepted means of confirming theories with probabilistic rigor. Notably, like Royce, she displayed marked consciousness of her place within the time she worked. “This is a crisis which calls for action,” she said, “but, also, the present moment permits it.”¹⁷

This crisis, she suggested, needs to be solved by creating consensus. She proposed that the Congress form a commission of “competent” philosophers who could set forth ideas that “meet the severe tests for validity which are a matter of course among the logicians and scientists.” The commission would exclude “all who believe that the syllogism can be proved by the laws of thought.” Instead, it would “be plentifully furnished with the members of that keen band of mathematical logicians who have lately been doing such heroic work in digging down into the foundations of logic and of mathematics.”¹⁸ Logicians would no longer constitute one subgroup within the field of philosophy. All of philosophy would be guided by the principles of logic, preferably her specific principles. In this way, philosophy could be restored to what she saw as its rightful place among the sciences.

This is the Doctrine of Histurgy. Ever the nonconformist, Ladd-Franklin coined the word, and, with typical attention to semiotics and the meaning conveyed by form, was careful that even the etymology of the term reflected its combination of previously disparate ideas. “Histo-,” the English prefix derived from ancient Greek, means web or tissue; “-urgy,” also from ancient Greek, connotes a technique for working with something. Histurgy, then, refers to an approach

¹⁷ Ladd-Franklin, “Epistemology for the Logician,” 666.

¹⁸ *Ibid*, 667.

that works with a carefully interwoven tissue of knowledge. Additional strands and pieces are carefully considered before added to a solid base created by consensus.

In the second half of her Heidelberg presentation Ladd-Franklin offered the beginnings of a basic proposal of what this doctrine must provide. In later publications and presentations, she focused on more specific elements of the doctrine and more directly relates them to her earlier proposals in logic. Though the two philosophies may appear similar, Ladd-Franklin made sure to state that Histurgy cannot be equated to Pragmatism, a philosophy that is “not only immoral but also untrue” and “its nearest foe.” It is not obvious whether she was distancing herself from Peirce’s use of the word, James’s later appropriation, or both. Histurgy, she proposed, must contain first a theory of reality. This theory should assume that the existence of a world external to oneself is purely hypothetical, albeit a “hypothesis of immense convenience and much probability indeed.”¹⁹ Furthermore, the doctrine demanded “a reformed psychology.” This inclusion further demonstrates the ways in which Ladd-Franklin truly considered philosophy adjacent to the natural sciences. Psychology may rely on descriptions of the human body from biologists, and the two fields blur together around the topics of neuroscience. Likewise, philosophy relies on psychology’s sound descriptions of the workings of the brain and the “not further analyzable constituents of consciousness.”²⁰

These constituents, among others, make up what Ladd-Franklin later referred to as primitives. Histurgy, she argued, must make these primitives explicit. In a 1911 paper on “The Foundations of Philosophy,” she described the work that must be done. She said that “this work consists in the main in bringing to light and setting down in plain black and white *all* the principles that have hitherto been let in surreptitiously—without full consciousness of what it is

¹⁹ Ibid.

²⁰ Ibid, 668.

that is being taken for granted.”²¹ She demanded that philosophy establish discernible basic tenets: here is what we know, here is what we are working through, here is what we would like to know and, critically, here are the accepted methods with which we can hope to find all of this out. This she insisted of all sciences, and not philosophy alone, but she had especially pointed criticism for her own field. “It would seem that these simple elementary considerations might have presented themselves spontaneously to all those who spend their lives in thinking,” she said in a transparent dig at her peers, “but certainly after the model has once been set by the mathematico-logicians, there ought to be no delay in following it.”²² Summarizing and analyzing existing views, as Royce did and as, she said, did the American Philosophical Association, was not enough. For philosophy to survive this new century of science, it had to firm up its foundations. This was to be done logically and categorically. As expected in formal scientific inquiry, philosophers must make clear what they don’t know and, of those, what is unknowable. To support and use their hypothesis, they are to list and describe the “explicit primitives” of their arguments. Not everything can be defined, so the undefinable must be “distinctly enumerated.” And not everything can be demonstrated, so the undemonstratable must be “explicitly assumed.”²³ Ladd-Franklin left no room for the vagueness and ambiguities that often plague philosophical arguments. Logic allows primitive statements to form the basis of induction. Repeated inductions that best align with perceived reality have an increased likelihood of being true. Per her consistent approach, Ladd-Franklin made sure to distinguish between types of primitives. Particulars should be referred to as postulates, while universals are axioms. This way, philosophers could make accurate translations of their arguments into a logical language.

²¹ Ladd-Franklin, “The Foundations of Philosophy,” 708.

²² *Ibid*, 710.

²³ *Ibid*, 709.

The final constituents of the Doctrine of Histurgy are the theories of judgement and truth. She described judgement similarly to Peirce, for whom it is the decision between doubt and belief when encountering a strange or unfamiliar combination of circumstances.²⁴ For her theory of truth, she combined the first and third motivations Royce delineates. Isolated instances are tested for truth by repetition. “Knowledge is a net-work, truths hang together,” by recurring in what are eventually discernable ways. Not all knowledge is discernible, but all that is can be discerned through the methods of knowledge. When, upon examination, two related truth-instances “enter severally into many other relations,” and some of these “relation-pairs may chance to constitute the premises of valid syllogisms.”²⁵

At Heidelberg, again at Baltimore, and everywhere else in between and afterward, logic was the answer. For Ladd-Franklin, logic presented the solution to the extensive and ever-expanding universe of philosophical inquiry. The Doctrine of Histurgy presented the assurance that all this thinking was going somewhere purposeful.

Though Ladd-Franklin’s doctrine did not ultimately gain much prominence, contemporary philosophers did pay attention to her proposal. Philosopher Karl Schmidt refers to it in a 1917 piece in *The Philosophical Review*, where he calls it “very fundamental.”²⁶ Her paper on explicit primitives garnered a critical response by then-Harvard (later Princeton) philosopher Warner Fite, who characterized her description of primitives as juvenile, like one of his first-year students.²⁷ In a fierce retort to this criticism, Ladd-Franklin published another piece, re-

²⁴ Charles Sanders Peirce, “The Fixation of Belief,” *Popular Science Monthly* 12(1877), 1-15.

²⁵ Ladd-Franklin, “Epistemology for the Logician,” 669.

²⁶ Karl Schmidt, “Reviewed Works,” *The Philosophical Review*, 26(1917), 82.

²⁷ Warner Fite, “Explicit Primitives: A Reply to Mrs. Franklin,” *The Journal of Philosophy, Psychology, and Scientific Methods*, 9(1912), 155-158.

explaining her claim. She ends with an impassioned and illustrative metaphor, worth quoting here in full:

Thus, the closely interwoven tissue of knowledge (hence the name, *histurgy*) is like a tree of many interlacing branches, which, though it may be for long stretches deductive and abstract, is nevertheless, a whole, constantly sending down shoots (like the banyan tree) into the solid ground of fact, and hence deriving incalculably strong support.²⁸

Ladd-Franklin valued philosophy and warned against the danger of its collapse. To survive, it required a strong base of interlocking inductions. Philosophy must not fear logic. Rather, it must embrace it, lest it be swallowed by its own inclusiveness. Her methodology demanded clarity, consensus, and a careful weaving of supportive steps that could, she ventured, allow philosophers to finally tackle the questions of human existence.

²⁸ Christine Ladd-Franklin, "Explicit Primitives Again: A Reply to Professor Fite," *The Journal of Philosophy, Psychology, and Scientific Methods*, 9(1912), 585.

Conclusion

In 2014, a group of scientists gathered, this time in Prague, for the twenty-first European Conference on Artificial Intelligence. This conference convenes every other year to present and discuss advancements in the applications of artificial intelligence and trends in its various subfields. Broadly defined, the field of artificial intelligence studies the design of intelligent agents—systems that perceive their environments and are able to take actions towards achieving their goals.¹ One of the nearly three hundred papers shared at the conference consists of a somewhat unique effort by computer scientists to write history. In “Some Elements for a Prehistory of Artificial Intelligence in the Last Four Centuries,” the authors recount the formulations and designs of machines before the advent of modern computing that eventually contributed to their rapidly expanding corner of computer science.²

As modern computing draws significantly from logic and aligned mathematical systems, their account essentially traces the history of logic and the mechanization of logical symbols. All the familiar players are mentioned—Boole, Peirce, and Jevons.³ And, in the spirit of accounting for the “forgotten names in the slow emergence of ideas,” the authors include Christine Ladd-Franklin.⁴ This reference constitutes the most recent citation of “On the Algebra of Logic,” the paper she published back in 1883.

It is fitting that this reference appears in this paper, as it exemplifies a return to the same boundary-crossing intellectual notions that Ladd-Franklin pursued. Its authors acknowledge that

¹ David Poole, Alan Mackworth, and Randy Goebel, *Computational Intelligence: A Logical Approach*, (New York: Oxford University Press, 1998), 1.

² Pierre Marquis, Odile Papini, and Henri Prade, “Some Elements for a Prehistory of Artificial Intelligence in the Last Four Centuries,” *Frontiers in Artificial Intelligence and Applications* (2014).

³ Jevons gets special mention for his Logic Piano, an early mechanical computer that calculated the conclusion of a logical argument based on inputted premises.

⁴ Marquis, Papani, and Prade, “Some Elements for a Prehistory,” 612.

the works that they mention “were often only small parts of the production of their authors, involved in very different scientific fields.”⁵ The research of their fellow conference attendees, they emphasize, must be seen as continuing “the synergies that have always been at work along centuries between sciences, technology, and also the world of imagination.”⁶ Some experts categorize computational intelligence as a form of “synthetic psychology,” or “experimental philosophy.”⁷ Similarly to the 1901 convening of the American Philosophical Association in New York and the 1908 International Congress of Philosophy in Heidelberg, these participants of this meeting of the ECAI emphasized the lack of distinct separations between academic disciplines. Their work requires breaking down the barriers between the various disciplines so carefully constructed a century earlier.

The institutionalization and specialization of academia at the end of the nineteenth century in both Europe and the United States allowed research to progress and expertise to develop. In some ways, Ladd-Franklin’s work in philosophy and logic celebrated this change. She thought that philosophers should convene to establish core principles and make explicit what topics could be further analyzed and what were to be considered primitive assumptions. At the same time, she subverted that ideal through her extensive and varied academic work. She was a true polymath, emphasizing connections in between disciplines and applying intricate ideas from one field to another.

Before the end of the nineteenth century and the emergence of the research university system, knowledge was more unorganized. But these changes solidified to produce artificial severances between approaches to that knowledge. Already in the 1890s, the “basic pattern of the

⁵ Marquis, Papini, and Prade, “Some Elements for a Prehistory,” 609.

⁶ Marquis, Papini, and Prade, “Some Elements for a Prehistory,” 612.

⁷ Poole, Mackworth, and Goebbel, *Computational Intelligence*, 6.

university...was that of a success-oriented enterprise whose less popular possibilities were deliberately blurred.”⁸ There was no room, institutionally, for such boundary-crossing as Ladd-Franklin practiced and preferred. The university system was used to support military, security, legislative, and capitalist efforts in the following years, and thus increased their focus on expediency instead of maximum intellectual expansion.

But traces of interdisciplinarianism have re-emerged, supporting the “flexibility of the academic impulse.”⁹ In 2005, the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine released a joint report titled *Facilitating Interdisciplinary Research*. The report emphasizes that scientific research “requires not only a depth of knowledge but also a breadth of knowledge, integration, synthesis, and an array of skills.”¹⁰ The committees found that “interdisciplinary thinking is rapidly becoming an integral feature of research as a result of four powerful ‘drivers’: the inherent complexity of nature and society, the desire to explore problems and questions that are not confined to a single discipline, the need to solve societal problems, and the power of new technologies.”¹¹ The report points to difficulties in pursuing such a model, including the need to re-establish connections between disparate fields and defining reliable models for review and confirmation.

Ladd-Franklin’s work serves as a model for this kind of careful barrier breaking. Despite her expansive academic interests and intellectual abilities, she was careful to be specific about the goals of the different realms in which she contributed.

⁸ Laurence Veysey, *The Emergence of the American University* (University of Chicago Press: Chicago, 1965), 439.

⁹ Veysey, *The Emergence*, 444.

¹⁰ *Facilitating Interdisciplinary Research* (National Academy Press: Washington D.C., 2005), ix.

¹¹ *Facilitating Interdisciplinary Research*, 2.

In an unpublished private note left among in her papers at Columbia, she discusses intellectual work, the reaches of philosophy and psychology, and the distinctions between them. She writes that “the sure sign of acute power of attention, or of genius, is to be able to fix the mind continuously on the point of a cambric needle.” Cambric is a type of linen cloth that was popular for use in needlework. The specifications of the needles used with this cloth are of no importance—the metaphor is that of a very small yet still existing point in space. She continues:

We may say further, perhaps, that the philosopher is required to move about continuously upon the tops of a whole field of cambric needles. Not everybody is able to do this, many fall off inadvertently and become simple psychologists without themselves noticing the change.

She explained that while philosophy deserves a place among the sciences, that does not mean it is exactly the same as some of its counterparts. Philosophy involves intense focus and clarity of thought—clear enough to distinguish between nearly indistinguishable points. Psychologists’ study of consciousness and mind is valid, but “syllogisms are equally a contest of the undeniable conscious experience!” Still, though,

The psychologist’s consciousness and the philosopher’s consciousness are two very different things. One is viewed from the outside—it is an object like other objects, and may be studied by the philosophers on Mars, if they chance to be interested in us and to have sufficiently good telescopes. But when the pure philosopher says consciousness, he means, or he should mean, consciousness when viewed from the inside.”¹²

¹² Christine-Ladd Franklin, *Needles*. n.d, Box 45, Christine Ladd-Franklin and Fabian Franklin Papers, Rare Book and Manuscript Library, Columbia University.

With these distinctions, Ladd-Franklin demonstrated her ability to hold cohesive views within what she insisted were vast interlocking worlds of thought in which she worked. Her work in logic reveals exceptional mathematical abilities. She then sent and expanded that work in all directions, showing her skill in focusing on the points of multiple needles without getting stuck on any single one.

Acknowledgments

Somehow, it's become common practice to write a page of acknowledgements for an undergraduate thesis. I think it might be a bit pompous. But hey, I'll take it.

The librarians and archivists at Columbia, Johns Hopkins, and Vassar were gracious and endlessly helpful. They all seem to be the kind of people I want to be when I grow up.

Barnard's Committee on Honors awarded me the Lucyle Hook travel grant, which allowed me to be the history student I dreamed I would be, learning and knowing the past in the places where that past went down and in the words and mementoes of those who lived it.

Professor Robert McCaughey has a never-ending bookshelf of relevant books, and always pulls down the exact right one. He's had to assure me that what I was writing was actually a history paper, and answered questions I didn't even know I was supposed to be asking. He's also always approved my strange collection of course choices without any questions. His comments and suggestions have been instrumental in shaping this paper.

Professor Robert Remez teaches the Psychology of Perception with the careful attention to technical detail of a scientist and the contemplative tone and expansive questions of a philosopher. His descriptions of the world of psychology during this era were illuminating, and I regret that I did not manage to explore the topic further. Next time, perhaps.

My professors and TA's over the past four years sometimes wrote nice comments on my papers and let me know that I had something worth saying. When they wrote not as nice comments, I deserved it.

My friends put up with nearly eight months of monologues about how everything is logic and nothing is logical, nodded as I marveled at illegible scribbles, allowed me inordinate space on the communal bookshelf, and tolerated my detours to take pictures with apartment buildings where strangers live. They're all the kindest and smartest people I know. They still aren't sure what any of this has to do with the magician I've been saying I'm writing about.

My family has been putting up with me for longer than anyone else, and still manages to take me seriously sometimes. They've driven with me around the country to old houses with rules against leaning on the furniture and to shoddily-organized museums of questionable legitimacy. They did away with the boundaries between disciplines, and modelled learning as a constant, never-ending venture. They've shown me that questions are worth asking and that people are worth paying attention to. I hope to keep asking good questions.

Appendix A: Timeline

This list of publications is likely not complete; it is especially lacking in non-academic publications, such as editorials. But, to my knowledge, this constitutes the most comprehensive list of Christine Ladd-Franklin's work.

Year	Personal Events	World/National Events	Publications
1847	Born in Windsor, Connecticut	George Boole Publishes <i>Mathematical Analysis of Logic</i>	
1861		Vassar College Opens Civil War	
1866	Enrolls in Vassar College		
1869	Graduates Vassar College		
1874			"Numerous Elementary Exercises from Planimetry"
1875			"Crelle's Journal"
1876		Johns Hopkins University Opens	
1877			"Quaternions"
1878	Enrolls in Johns Hopkins University		"Geometric Places that Lead to Conics" "About the Parabola" "About Conics in General" "Theorems and Exercises from Stereometry" "Problems of Geometric Loci that Lead to Third and Higher Degree Curves" "The Polynomial Theorem" "On Some Properties of Four Circles Inscribed in One and Circumscribed about Another"

Year	Personal Events	World/National Events	Publications
1879			<p>“Congruence of the First Degree When the Modulus is a Composite Number”</p> <p>“The Pascal Hexagram”</p> <p>“Landen’s Theorem”</p>
1880			<p>“The Nine-Line Conic”</p> <p>“On De Morgan’s Extension of the Algebraic Process”</p> <p>“On Triangles, Quadrilaterals, and Polygons”</p>
1881			<p>“Plane Curves of Degree Higher than Two”</p> <p>“Further Solutions of Problems in Probability”</p> <p>“On Segments Made on Lines by Curves”</p>
1882	<p>Completes requirements for a Ph.D.</p> <p>Marries Fabian Franklin</p>		<p>“Evaluation of Definite Integrals”</p> <p>“Problems on Geometric Probability”</p>
1883			<p>“On the Algebra of Logic”</p> <p>“Further Solutions of Dynamic Tasks”</p> <p>“Second-Order Surfaces”</p> <p>“On Triangles and Squares”</p> <p>“Further Solutions of Problems on Special Series”</p>
1884	<p>Birth of Margaret Ladd-Franklin</p>		

Year	Personal Events	World/National Events	Publications
1887			“A Method for the Experimental Determination of the Horopter”
1889			“On Characteristics of Symbolic Logic”
1891	Spends Year in Germany		“On the So-Called d’Alembert-Carnot Geometrical Paradox”
1892		International Congress of Psychology Meets in London	“A New Theory of Light Sensation”
1893	Inducted into the American Psychological Association		
1895			“The Positions of Retinal Images”
1896			“The Higher Education of Women”
1901	Returns to Europe		<i>Dictionary of Philosophy and Psychology</i> (associate editor) “Color-Introspection on the Part of the Eskimo”
1902		First Meeting of the American Philosophical Association in New York	
1903			“Seeing through the Veil”
1904	Begins Teaching at Johns Hopkins University		“Endowed Professorships for Women”
1908		The Third International Congress of Philosophy Meets in Heidelberg	“Epistemology for the Logician” “On Some Characteristics of Symbolic Logic”
1910	Begins Teaching at Columbia University		

Year	Personal Events	World/National Events	Publications
1911			<p>“The Foundation of Philosophy: Explicit Primitives”</p> <p>“The Sarah Berliner Fellowship”</p>
1912			“Implication and Existence in Logic”
1913			<p>“A Non-Chromatic Region in the Spectrum for Bees”</p> <p>“the Antilogism—An Emendation”</p>
1914		World War I	
1916			<p>“An Introduction to the Study of Color Vision”</p> <p>“On Color Theories and Chromatic Sensations”</p>
1917			“Explicit Primitives Again: A Reply to Professor Fite”
1920			“A Logic Test”
1922			“Tetrochromatic Vision and the Development Theory of Color”
1923			“Practical Logic and Color Theories”
1925			<p>“The Theory of Blackness”</p> <p>“The Nature of Color Sensation”</p>
1926			<p>“The Reddish Blue Arcs and the Reddish Blue Glow of the Retina: Seeing Your Own Nerve Currents through Bioluminescence”</p> <p>“A Logic Poem”</p>

Year	Personal Events	World/National Events	Publications
1927	Receives Ph.D. from Johns Hopkins University		<p>“The Physicist and the Facts of Color”</p> <p>“Visible Radiation from Excited Nerve Fiber”</p> <p>“Proof that nerve when excited, and probably also when not excited, emits physical light”</p>
1928			<p>“The Antilogism”</p> <p>“Visible Radiation from Excited Nerve Fiber Again”</p>
1929			<i>Colour and Colour Theories</i>
1930	Dies in New York		
1931			<p>“The Non-Existence of Existence: The Pure Idealist and the Hypothetical Realistic” (published posthumously, in French)</p>

Appendix B: Photographs



Christine Ladd, ca. 1865.
Special Collections, Vassar College.



Christine Ladd-Franklin, ca. 1865.
Smithsonian Institute Archives.



At 417 Riverside Drive, Ladd-Franklin's residence ca. 1930.
Address found in letters in the Johns Hopkins University Archival Collections, Records of the Office of Alumni Services.



At 617 W. 113th Street, Ladd-Franklin's residence ca. 1930.
Address found in letters in the Johns Hopkins University Archival Collections, Records of the Office of Alumni Services.

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