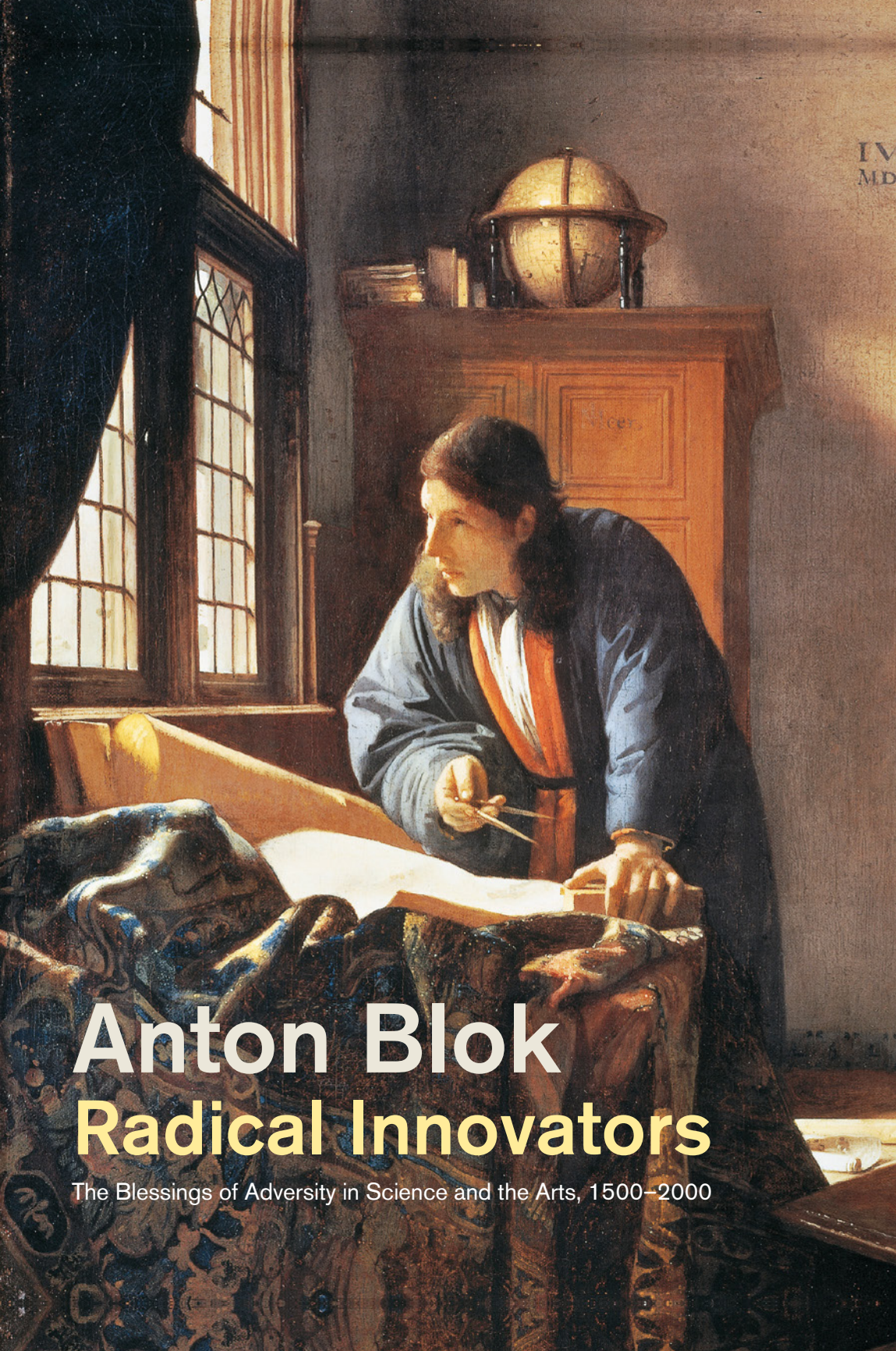

Anton Blok

Radical Innovators

The Blessings of Adversity in Science and the Arts, 1500–2000

Radical Innovators

Radical Innovators

The Blessings of Adversity in Science and the Arts, 1500–2000

Anton Blok

polity

First published in Dutch as *De vernieuwers*, © Anton Blok, 2013

This English edition © Polity Press, 2017
This publication has been made possible with financial support from the Dutch Foundation for Literature

Nederlands letterenfonds dutch foundation for literature

Polity Press
65 Bridge Street
Cambridge CB2 1UR, UK

Polity Press
350 Main Street
Malden, MA 02148, USA

ISBN-13: 978-1-5095-0551-7
ISBN-13: 978-1-5095-0552-4 (pb)

A catalogue record for this book is available from the British Library.

Library of Congress Cataloging-in-Publication Data

Names: Blok, Anton.
Title: Radical innovators : the blessings of adversity in science and the arts, 1500-2000 / Anton Blok.
Other titles: Vernieuwers. English
Description: English edition. | Cambridge : Polity, 2016. | Includes bibliographical references and indexes.
Identifiers: LCCN 2016016765 (print) | LCCN 2016025562 (ebook) | ISBN 9781509505517 (hardcover : alk. paper) | ISBN 1509505512 (hardcover : alk. paper) | ISBN 9781509505524 (pbk. : alk. paper) | ISBN 1509505520 (pbk. : alk. paper) | ISBN 9781509505548 (mobi) | ISBN 9781509505555 (epub)
Subjects: LCSH: Science--History. | Art--History. | Anthropology.
Classification: LCC Q125 .B582713 2016 (print) | LCC Q125 (ebook) | DDC 509/.03--dc23
LC record available at https://lccn.loc.gov/2016016765

Typeset in 10.5 on 12pt Sabon by Servis Filmsetting Ltd, Stockport, Cheshire
Printed and bound in the UK by Clays Ltd, St. Ives PLC

CONTENTS

PREFACE AND ACKNOWLEDGMENTS

This book investigates how people from different backgrounds and in different circumstances could accomplish a breakthrough in science or the arts. What did these pioneers, along with their differences, have in common? Which forces were operating in the development of a new point of view?

Insofar as these questions have been raised before, scholars have searched for an answer in the area of talent, intelligence, and other inborn gifts. Subsequent longitudinal research, however, has shown that highly intelligent students are not always also highly creative.[1] More recent research emphasizes the early acquisition of skills with feedback from a mentor: informal teaching, including self-study, is more likely to encourage radical innovation than formal education.[2] Due to the lack of systematic comparative research, little is known even now about the circumstances and drives that moved these people, often at an early age, to excel in a specific field of science or the arts and produce trailblazing achievements. The present book explores a collective biography of about one hundred pioneers in the sciences and the arts working in Europe and North America between about 1500 and 2000. The strength of a collective biography, writes Tilly, is not in supplying alternative explanations, but in specifying what is to be explained.[3]

To anticipate the outcome of this research, nearly all the pioneers were confronted with early adversity resulting in social exclusion. Adversity could take different forms, including illegitimate birth, parental loss, parental conflict, the father's bankruptcy, chronic illness, minority status, poverty, physical deficiencies, detention, and exile. In histories of science and the arts, some of these conditions or "factors" have been explored to explain radical innovation, but

mostly in the form of one-factor analysis, including chronic illness, parental loss, and birth order. What *all* the different forms of adversity turn out to have in common – justifying the use of one common denominator – is social exclusion, which implies the strategic position of the outsider. This comes down to Butterfield's recommendation of "handling the same bundle of data as before, but placing them in a new system of relations with one another by giving them a different framework."[4] Bringing together a host of phenomena, usually seen as separated from one another, under one common denominator, as attempted in this book, constitutes a synthesis which Kuhn has called a "discovery."[5] Having little to lose, outsiders are more likely to notice and take chances to find a niche – including protection and support from relatives, friends, teachers, mentors, or patrons. As outsiders, they also have more space and freedom to experiment in their field – and are therefore more likely to notice anomalous, unanticipated, and strategic data in their field.[6]

The research for this book has taken about ten years. An early interest in biographies (at high school in the 1950s) could be turned into a systematic inquiry of a substantial collective biography. Second, I had to familiarize myself with the state of the art: the discussion among historians and psychologists on groundbreaking work of the great pioneers in science and the arts active between about 1500 and 2000. For a better understanding of the roots of radical innovation in these fields, the present book argues for a more comparative sociological and anthropological approach focused on the social position of pioneers: their place in sets of social relationships, whether institutional, conjunctural, or both.[7]

In writing this book, I have incurred numerous debts to friends and colleagues. An early single bibliographical reference had far-reaching consequences for the argument of this project. In a brief exchange, visiting classicist Karin Bassi referred me to Syme's statement on the position of Thucydides: "exile may be the making of an historian. That is patent for Herodotus and Polybius. If a man be not compelled to leave his own country, some other calamity – a disappointment or a grievance – may be beneficial, permitting him to look at things with detachment, if not in estrangement."[8] This observation dovetailed with the overall detachment and aloofness that mark the habitus of the radical innovators outlined in the collective biography.

I am also indebted to Peter Burke, who carefully read the Dutch version of the book shortly after its publication in the fall of 2013. His letter provided several corrections of names and places as well

as pointing out the absence of some outstanding examples of radical innovators who had been affected by early adversity, including Leonardo da Vinci (illegitimate birth, homosexual), Michelangelo (parental conflict, homosexual), and itinerant Thorstein Veblen (émigré, minority status, poverty). The book certainly shows "omissions" but this is perhaps inherent, even in a substantial collective biography that covers a long period of time. The foremost intention was to search for recurrent patterns in the collective biography and to make sense of them: explaining that following adversity and social exclusion, radical innovators tended to be outsiders – having less to lose, they could take more risks than their established colleagues, who tended to stick to mainstream views and practices.

Omissions may provide test cases. I hesitated to include the great Dutch painter Johannes Vermeer (1632–75), a contemporary of Spinoza: little is known about Vermeer's youth. Research over more than a century produced more questions than answers, as Montias notes in his painstaking biography of Vermeer and his milieu in which he is careful "to identify conjectures and not let them be confused with solid facts."[9] All we know from documented facts about his youth are his baptism in October 1632 in Delft, as the son of a Protestant innkeeper and art dealer, and his conversion to Roman Catholicism to marry a girl from a rich and distinguished Roman Catholic family in April 1653 in nearby Schipluy. This step also made him a member of a minority discriminated against in Delft's predominantly Protestant population.[10]

The same year Vermeer entered St. Luke's Guild as a master painter. The local guild became the center of his public life. Vermeer kept a low profile. He lived with his wife (who gave him no fewer than fifteen children) in the big house of his wealthy mother-in-law, where he also had his studio. She took a genuine liking to him and from the beginning financially and materially supported her daughter's family. Biographer Montias notes that Vermeer's absence from Delft's notarial archives "makes it seem as if he wished to withdraw from civil society, perhaps because he was engrossed in his work or because he had joined a religious minority subject to prejudice and discrimination."[11] These circumstances help explain his modest production of masterworks, with rarely more than two paintings on average a year. Vermeer had one major patron and collector and never accepted commissions.[12]

Acknowledgments

In writing this book, I have incurred numerous debts to friends and colleagues. Apart from those already mentioned above, Karen Bassi and Peter Burke, I am most grateful for suggestions and comments to Chris de Beet, Chris Connery, Arturo Giraldes, Donna Goldstein, Johan Heilbron, Longina Jakubowska, Job Lisman, Nienke Muurling, Mai Spijkers, Thijl Sunier, and Bonno Thoden van Velzen. Some friends have taken the trouble to read earlier versions of the entire manuscript. For a critical last-minute reading I would like to thank Henk Driessen: in a book of this scope a reference to the life and work of Van Gennep could not be missed. Rod Aya has been my sparring partner from the very beginning of this project. As before on similar occasions, I have learned a great deal from his comments and I am also grateful for his editorial help. I am especially beholden to Huub de Jonge. Over the years, he has been my most constant source of stimulus and illumination, providing comments on the manuscript in its various stages and suggesting numerous editorial improvements. Finally I owe a special debt to Ann Bone, copy-editor at Polity Press, who greatly improved the original manuscript down to the smallest details.

Soest, The Netherlands
May 31, 2016

For granted that individuals may have historical effect, they have to be in a position to do so, as Raymond Aron reminds us, and "position" means a place in a set of relationships, whether institutional, conjunctural, or both. We have to overcome certain received ideas of an unbridgeable opposition between cultural order and individual agency . . .

Marshall Sahlins, *Apologies to Thucydides*

— 1 —

THE MARGINS AS A PLACE OF INNOVATION

> Many men who are very clever – much cleverer than the discoverers – never originate anything.
>
> Charles Darwin, in a letter to his son, 1871[1]

Recent research into the history of science shows that radical innovation did not come from people who were more talented, intelligent, or knowledgeable than ordinary people. Nor did radical innovators mostly come from privileged backgrounds. What distinguished them from ordinary people was an early and overpowering interest in a specific branch of the arts or science and seizing windows of opportunity. Their dedication was both lasting and passionate; it took them from self-study to an extended period of apprenticeship in relative isolation, often with a mentor providing feedback. Rather than talent or skill, daily practice and chance encounters were decisive.[2]

This book provides a detailed empirical and theoretical account of this viewpoint, spelled out on the basis of a collective biography of about one hundred radical innovators, virtually all of them active in Europe and North America in the past five hundred years. This so-called prosopographic approach is comparative and analyses the background, location, and setting of innovators. According to sociologist and historian Charles Tilly,

> the strength of collective biography is not in supplying alternative explanations, but in specifying what is to be explained. Historians who have specified what is to be explained via collective biography often find themselves turning to explanations stressing the immediate setting and organization of everyday life, or relying on something vaguely called "culture." That moves them back toward anthropology.[3]

What did radical innovators have in common that enabled them to distinguish themselves from ordinary mortals? Why Charles Darwin? Why Sigmund Freud? Why Albert Einstein? Why Jane Goodall? To say, as generations of historians of science and cognitive psychologists have done, that they had more talent or were more creative is not wrong but tautological and begs the question. To say that most of them were young or new to the field in which they made new discoveries is only taking one step in a promising direction, leaving open the background of their drive and failing to explain late production.[4]

The history of science is more about science than about scientists. As the history of ideas it remained a disembodied affair. Biography as a genre is still primarily descriptive and is only rarely comparative and analytical. Therefore it fails to suggest or establish compelling links between the life and the work of its subjects. If the author of a recent biography of Galileo is correct when he says that "biography is not seen as a respectable genre by professional historians,"[5] this may be largely attributed to the predominance of the monographic – and not infrequently monomaniac – treatment of isolated cases at the expense of comparative research. Another critical historian of science concludes that it is "difficult for authors of a case study not to become prisoners of their subject. The stronger the lens used by the observer, the greater the possible discovery, and the greater also the danger of becoming so involved in one's case that one forgets to distance oneself from it. At that point no generalization is possible."[6]

The situation is no different in the history of art and literature. Both focus primarily on art and literature themselves, leaving the life and work of their practitioners to biographers, who usually restrict themselves to one particular person and his or her work. Here, too, life and work remain separated, making any attempt at explanation strongly ad hoc in character. One misses a comparative perspective focusing on context: the social position of innovators, their place in networks of relationships from their earliest youth onward – an approach that can identify similarities and differences in the lives of innovators and also pays attention to "negative" cases: people who might have been innovative but who refrained from taking a further decisive step.

This book attempts to explore these uncharted territories by systematically comparing the lives of about one hundred scientists and artists whose work both has been innovative and has had an enduring impact. The criterion for selection is a canon of *reconceptualization* or radical innovation.[7] For scientists this comes down to the presentation of a new and more comprehensive perspective. In the

early seventeenth century, for example, William Harvey's discovery of the blood circulation system was based on an analogy: the heart functioning as a (single) pump at the center. Harvey's system replaced the multiple systems posited by Galen. This was not the only discovery based on an analogy. Darwin's discovery of natural selection as the driving force of the evolution of species, relegating the theory of creation to the realm of myth (and proving the contemporary belief in the inheritance of acquired properties wrong), was an achievement of similar proportions and also founded on several analogies.[8] Nicolaus Copernicus's heliocentric model of the world replaced the prevailing geocentric model of Ptolemy based on countless loose observations. Using Johannes Kepler's discovery of the elliptical orbits of planets, Isaac Newton completed the Copernican revolution with his discovery of the universal law of gravitation. Most likely as a tribute to the work of his predecessors Kepler and Newton, whom he admired, Einstein observed that "No fairer destiny could be allotted to any physical theory, than that it should of itself point out the way to the introduction of a more comprehensive theory, in which it lives on as a limiting case."[9]

To find out what radical innovators had in common and to arrive at a new perspective, I also explored a number of scientists who could have been innovative, but stuck to received wisdom. These "negative" cases enable us to sort out independent variables that help account for radical innovation.[10] Which circumstances enabled the young Einstein to formulate the special theory of relativity while Hendrik Lorentz and Henri Poincaré – much older scholars – only came very close? All three scientists possessed an *esprit préparé*, to use Louis Pasteur's famous phrase about the role of chance in scientific discovery.[11] What stopped two of them, with hindsight, from taking that single step? How and why could Newton complete the Copernican revolution with his discovery of the law of universal gravitation, while fellow scientists Robert Hooke and Christiaan Huygens did not? What enabled Baruch Spinoza to emerge as the radical pioneer of the Enlightenment, rather than his contemporary Gottfried Wilhelm Leibniz? Darwin and Alfred Russel Wallace, though from different backgrounds – the opposite sides of Victorian England – simultaneously discovered the struggle for existence and natural selection as the driving forces of evolution. What did they have in common and where did they differ from their colleagues? The same questions apply to breakthroughs in modern art: why Ludwig van Beethoven, Henrik Ibsen, Paul Cézanne, Vincent van Gogh, Arthur Rimbaud, Constantin Brâncuşi, and Franz Kafka, and not one of their teachers or fellow artists?

To answer these questions this book focuses on the blessings of adversity in the lives of about a hundred artists and scientists in Europe and North America between approximately 1500 and 2000. Their work not only brought about fundamental innovations, but also had a lasting impact. It still appeals to us today – often also because of the surprising simplicity and elegance of their findings and discoveries.[12] Their vision changed the way we see the world and ourselves. Some of them have become historical figures. Others – like Darwin with *The Origin of Species* (1859), Freud with *The Interpretation of Dreams* (1900), and Max Weber with his study of the Protestant ethic and the spirit of capitalism (1905) – are still our contemporaries. We have made ourselves familiar with great works of art. They have become part of our mental world, part of how we see, feel, and think about life. We can identify with Antigone, Hamlet, and Rembrandt's Bathsheba, and with many other unforgettable female characters in literature, including Tolstoy's Anna Karenina, Ibsen's Hedda Gabler, Strindberg's Miss Julie, Schnitzler's Fräulein Else, and Tennessee Williams's Blanche DuBois. All these examples show the relative autonomy of artists and their art with respect to the societies from which they came. According to Norbert Elias, the question about the relative autonomy of the artist has yet to be answered, but "its complexity should not relieve us from the obligation to further explore the relationship between creator and society."[13]

What all these achievements have in common, both in the arts and science, is originality and the effect of an enduring esthetic sensibility. People speak of the "intrinsic beauty" of the double helix structure of the DNA molecule, the discovery of which pointed the way to the transmission of genetic materials ("information") and opened the era of molecular biology. According to one of the discoverers, the structure was "too pretty not to be true."[14] Kepler's discovery of the elliptic orbits of planets has been called a prime example of elegance in science and the beauty of simplicity.[15] The same qualities have been ascribed to Einstein's special relativity theory, and he later illustrated that in a presentation in 1933: "It is true that the theoretical physicist who has no sense of mathematical elegance, beauty, and simplicity is lost in some essential way."[16] Darwin's theory of natural selection as the principle of evolution also unmistakably shows, along with the additional principle of divergence, the elegance and simplicity of a scientific discovery. The description applies to Newton's discovery of the universal force of gravitation, which keeps planets and moons in their orbits. Inspired by Huygens, Newton benchmarked the concept of "centripetal

forces." The core theme of his *Principia Mathematica* was the quantitative elaboration of this new concept. Perhaps we should realize that the scientific researcher and the artist face similar tasks. Both are in search of unity, structure, and coherence in a plethora of isolated data and information.[17]

Anticipating the main conclusions of this study, I mention the independent variables – the antecedents in the lives of radical innovators that should explain the dependent variable of radical innovation. They try to answer the question of why these people rather than others were able to bring about radical innovation in science and the arts. Here we are dealing not just with one factor or variable which applies in all cases, but with a set of necessary conditions in varying combinations which occur in the antecedents of each radical innovator.[18] In a single stroke they can be brought together under the common denominator of *adversity*. Recall that problems are often solved – and new discoveries made – not by providing more information but by rearranging what is [already] known.[19]

Based on a substantial collective biography, the present research indicates that radical innovation has come from people who had to deal with far-reaching forms of adversity, mostly at an early age, including illegitimate birth, early loss of parents, abuse by parents or other members of the family, conflict with parents, bankruptcy (of the father), social degradation of the family, poverty, minority status, peripheral origin (coming from peripheral areas), illness, physical deficiency, demotion, exile, and incarceration. All these forms of adversity, often in combination, resulted in social exclusion and alienation from mainstream life. Prevailing practices and views were no longer taken for granted; they were questioned. Social exclusion and alienation created the space and freedom for the development of new insights – the spur to radical innovation in science or the arts, which could not take place without seeing and seizing chances – windows of opportunity. Looking back on these lives, a pattern of adversity and exclusion unfolds in the scenario of radical innovation. Such an outcome can only be traced and understood with the benefit of hindsight. We may agree with historian Carlo Ginzburg, who is skeptical "about the teleological approach that sees a sort of straight line going from the childhood of an individual to his or her maturity . . . Constraints don't work in a definite direction . . . . You can become an atheist because you are the son of a priest, but you can also become a saint. The outcome is predicable only retrospectively."[20]

Desiderius Erasmus (1466/9–1536) *was* the son of a priest and subject to humiliation and discrimination as a child because of his

illegitimacy, a double anomaly. He claimed to have suffered from it his whole life. Moreover, he was strikingly small of stature, a deficiency his friend Hans Holbein disguised in his famous portraits of Erasmus.[21] Apart from some loyal friends and kindred spirits in England, Italy, Switzerland, Germany, and the southern Netherlands, Erasmus did not want to belong to any group, and this was eventually held against him by both Roman Catholics and Protestants. The religious tensions escalated to such an extent that in 1529 Erasmus was forced to leave his beloved Basel after the city had chosen the side of the Reformists. Erasmus settled elsewhere, at Freiburg, "to safeguard his independence."[22]

During his adult life Erasmus traveled widely through Europe but never revisited his native land. Apart from his years at the Latin school of the Brothers of Common Life, in Deventer, and later in 's-Hertogenbosch, Erasmus did not have good memories of that time. It was not just because of his illegitimate birth and the death of both his parents in a plague while he was still a child; he also hated the monastic schools to which his guardians sent him. Later he felt the same about the study of theology, for which his patron, the Bishop of Cambrai, provided a scholarship. Erasmus did not finish these studies. Huizinga summarized his trials with an understatement: "circumstances had not made it easy for him to find his way."[23] Yet all these disappointments would later form the breeding ground for his most famous book, *The Praise of Folly* (1511): his best and lasting work, Huizinga stated, "for only when humor illuminated that mind, did it become truly profound. In *The Praise of Folly* Erasmus produced something that no one else could have given the world."[24]

As this book seeks to point out, adversity resulting in exclusion is not only the basis for social dislocation but also for the development of radicalism, the formation of a rebellious mind and the development of a new perspective. A person is not only hardened by adversity; in relative isolation they can also be inspired by it and go on to achieve beyond expectations. Anthropologist Claude Lévi-Strauss (1908–2009), belonging to the Jewish minority in France in the 1920s, spoke for many when he remarked in an interview, as his biographer observed, "Being part of a traditionally persecuted group brought a heightened awareness and a sense that he had to overachieve in order to compete fairly."[25]

Of course not all outsiders have opened new horizons in science or the arts. We are talking about necessary, not sufficient, conditions. The researcher should avoid making the logical error and confuse the necessary with the cause, or "affirming the consequent." As Taleb

explains: "That all millionaires were persistent, hardworking people does not make persistent hard workers become millionaires."[26] Most outsiders have disappeared in anonymity. The unfavorable connotations of the word "outsider" reflect a common unfortunate fate. But some outsiders have challenged vested interests and views, and tried their luck. As outsiders they had little to lose and could therefore take more risks. To survive, they took risks in their search for a niche of meaningful activities that required solitude; hence their choice of a field in science or the arts and their first steps on this road in the form of self-study. Some of them were fortunate enough to get a chance and alert enough to note and take advantage of such windows of opportunity – offered by parents, other kin, friends, teachers, mentors, mediators, patrons, or sponsors. These serendipitous encounters turned out to be decisive. By means of self-study, and encouragement, material support, and feedback from a mentor, they developed a growing interest in a specific subject. Early in their apprenticeship this interest took on an enduring character; it became a passion to which all other activities were subordinated. Their work became a calling – a dedication dominating everything. The word "passion" is used here in its double meaning, well rendered in the German *Leidenschaft*, about which Hegel noted, "Es ist nichts Grosses ohne Leidenschaft vollbracht worden, noch kann es ohne Solche vollbracht werden [Nothing great has been achieved without passion, nor can it be achieved without it]."[27] This circumstance also explains the striking similarities in their lifestyle and habitus, which have often been wrongly given the unfortunate designation of "personality," with that considered the explanation of their innovativeness. No less misleading is the question about the "motivation" of innovators. Where love, zeal, dedication, and passion set the tone, the use of the term "motivation" is out of place.

Discussing parts of the first versions of this book with friends and colleagues, I was often asked why so few women appear in the collective biography. Prejudice was suspected. As is generally known, but less well explained, most radical innovators in science and the arts have been men – in spite of the considerable emancipation of women in the twentieth century. In his historical overview, *Human Accomplishment: The Pursuit of Excellence in the Arts and Sciences* (2003), Charles Murray explains why women across the board form a minority in the pursuit of excellence in science and the arts:

> When we discuss accomplishments ... we are commonly talking about perfectionist, monomaniacal devotion to a calling. That calls

> for a much more ruthless tradeoff than the ones ordinarily required by a job and children. We should not be surprised or dismayed to find that motherhood tempers the all-consuming obsession that great accomplishment in the arts and sciences often requires.[28]

As Murray explains,

> Motherhood affects women's achievement through several mechanisms. The central importance of motherhood means that many women do not want to jeopardize the opportunity to become a mother. Single-minded devotion to a profession involves such a risk. Recall that the mean age at which peak accomplishments occur, following years of preparation, has been about 40. The years crucial to realizing great achievements have been precisely those years during which women are sexually most attractive, best able to find mates, and best able to bear children.[29]

Western societies long remained a predominantly masculine social order, with laws made by men and with magistrates who judged the behavior of women from a masculine viewpoint. This was observed in a draft by the Norwegian playwright Henrik Ibsen (1828–1906) for his pioneering stage play *A Doll's House* (1879).[30] To have their books published (around the middle of the nineteenth century), the unmarried Brontë sisters had to use male pseudonyms.[31] At the time, literature was (still) considered a male profession and not a suitable one for women.[32] The interests of the young Freud (1856–1939) were self-evidently put before those of his sisters: "When, intent on his schoolbooks, he complained about the noise that Anna's piano lessons were making, the piano vanished never to return."[33] This incident took place in about 1870 in Vienna. For many more years, "a room of one's own" remained an unfulfilled desire, even for women in the homes of the western intelligentsia. In *La domination masculine* (1998), anthropologist Pierre Bourdieu argued that male dominance is so firmly entrenched in our unconsciousness that we do not notice it anymore, that it is so much in accordance with our expectations that we have difficulty raising it for discussion.[34] This point of view sharpened one of Bourdieu's key concepts: "symbolic violence."

The women mentioned in this book confirm the results of the observations of both Murray and Bourdieu: women were a tiny minority among the pioneers in science and the arts. Most of them were unmarried, or single at the time of their breakthrough; still others were married and worked together with their partner and had no children. They include Jane Austen (1775–1817); Emily Brontë (1818–48); Marie Anne Paulze (1758–1836) – wife of Lavoisier;

Marie Sophie von Brühl (1779–1837) – wife of Clausewitz; Marianne Weber (1870–1954) – wife of Max Weber; Virginia Woolf (1882–1941); Hannah Arendt (1903–75); Germaine Tillion (1907–2008); Simone de Beauvoir (1908–86), who with *The Second Sex* (1949) heralded a "reconceptualization" of women; and Jane Goodall (1934–) – twice married, but after her innovations in primatology.

A third variant includes the Polish émigrée Marie Curie (born Skłodowksa, 1867–1934), winner of two Nobel prizes (physics in 1903; chemistry in 1911). In 1895 she married her former teacher Pierre Curie, with whom she shared the Nobel prize for physics; from this marriage she had two daughters, born in 1897 and 1904. They were taken care of by a foster-mother and later educated by her father-in-law, a widowed medical doctor, who lodged with them; later these tasks were taken on by a governess.[35] Paulze, Von Brühl, and Marianne Weber not only substantially contributed to the work of their respective partners, Antoine Lavoisier, Carl von Clausewitz, and Max Weber, but also went on to complete their work after their death and take care of its posthumous publication. In this way, they ensured their international reputation as radical innovators. Alma Reville, the wife of Alfred Hitchcock (1899–1980), also closely cooperated with her partner from the very beginning: every film under his name was a collective product.[36]

The men in this biographical research show a similar pattern. Most of them were single, including Erasmus, Copernicus, Galileo, Thomas Hobbes, René Descartes, Spinoza, Newton, Leibniz, David Hume, Adam Smith, Alexander von Humboldt, Gregor Mendel, Elias, and Grigori Perelman – or unmarried before their breakthrough, like Herman Boerhaave, Alfred Wegener, John Maynard Keynes, James Watson, and W. D. Hamilton,[37] while a handful of married ones, including Darwin, Einstein, and Freud, can be considered functionally single because their wife took care of the household and the education of the children. This was also the case in the families of Kepler and Johann Sebastian Bach, who each married twice and had large families. Bach's second wife was a young soprano and helped him substantially with his work, including copying his scores. Freud's wife was a typical *Hausfrau* and the family revolved around Freud, who summarized his lifestyle in a single sentence when he remarked, "I cannot imagine life without work as really comfortable."[38] Darwin's son Leonard, one of his eight children, said his father was "never comfortable except at work. He hated idleness and talked about holidays as a punishment for the pleasure he had in his work." To his friends he expressed himself in similar words.[39]

The unmarried state is not only the most visible aspect of a lifestyle of seclusion among radical innovators. With the dominating devotion to work it is also the most revealing element because of its implicit rejection and undermining of fundamental social institutions: marriage, family, and community. In his stage play *An Enemy of the People* (1882) Ibsen shows that the community is not the noble and reliable social institution most people usually take it for. As Friedrich Nietzsche recognized in his statement, "Jede Gemeinschaft macht, irgendwie, irgendwo, irgendwann – 'gemein' [Every community makes – somehow, somewhere, sometime – *mean*]."[40]

No less relevant for the argument of this book are marriages that remained childless – and therefore, strictly speaking, did not form a "family" – as exemplified in the cases of Harvey, Lavoisier, Clausewitz, Michael Faraday, Alexis de Tocqueville, James Maxwell, Weber, Keynes, Giuseppe Tomasi di Lampedusa, and Samuel Beckett. In some of these cases, the wife substantially contributed to the work of her husband and also edited his posthumous publications, as already noted in the cases of Lavoisier, Clausewitz, and Weber. Clausewitz's only book, the standard work *On War*, appeared after his untimely death, completed and edited by his wife, Marie Countess von Brühl. After Weber's death, his wife Marianne Weber completed and edited the major part of his work and only then did it become widely known. Their marriage, as in the cases of Lavoisier and Clausewitz, was an intellectual comradeship, which also held good for Hannah Arendt, Simone de Beauvoir, and Jane Goodall, whose partners shared their interests.

What is revealing for the argument of this book is the "negative" case of Mileva Marić, Einstein's first wife. She was four years older than him and had been his sparring partner in discussions on physics since they studied together at the Polytechnic Institute in Zurich during the last years of the nineteenth century. She was his "brilliant inspirer and guardian angel," as he wrote to her and as he also told her father in Serbia during a visit to her paternal home in Novi Sad. In a letter of March 27, 1901 he phrased her part in his work as follows: "I'll be so happy and proud when we are together and bring our work on relative motion to a successful conclusion."[41] Yet Mileva lost her interest in science when she became pregnant and had children. Her place as interlocutor/discussant and sounding board was taken over by Maurice Solovine and Conrad Habicht, with whom Einstein formed the informal discussion group "Akademie Olympia." After they had left Bern in 1904, Einstein's friend Michele Besso became his colleague at the Patent Office and

had a decisive part in Einstein's embarking on the relativity theory in 1905.[42]

Mileva was not the only brilliant woman who, after helping her partner along the path to breakthrough and fame, had to settle for less once she became pregnant and had children. About the same time – in the early 1900s – a similar fate befell sculptress Clara Westhoff shortly after she married Rainer Maria Rilke, whom she had introduced to Auguste Rodin, her teacher, in Paris. Soon after she had given birth to a daughter, Rilke left her. Although they stayed in touch, eventually Clara had to take care of herself and her daughter, and for her entire life she remained "Frau Rilke," in the shadow of the poet. Meanwhile, he created a furore, mostly traveling from one castle in Europe to another, working at the invitation of mostly wealthy, aristocratic, and predominantly female protectors.[43] Rilke was undoubtedly the most itinerant of the innovative artists of his time.[44] "Il faut travailler, rien que travailler. Et il faut avoir patience [You have to work, only work. And you have to have patience]" was Rodin's favorite maxim, which Rilke approvingly wrote down when he was the sculptor's biographer in the early 1900s – observation and hard work replaced waiting for inspiration.[45] In the fall of 1907, Rilke wrote to his wife in the artists' colony at Worpswede near Bremen about his almost daily visits to Cézanne's retrospective at the Salon d'Automne in Paris, a year after the painter's death. Much later, the letters culminated in his *Briefe über Cézanne*.[46] Both Rodin and Cézanne had a decisive influence on Rilke. They made him put in the hard work to get to the bottom of things, his poem "The Panther" being an early and famous example.

All the scientists and artists who figure in this book subordinated nearly everything to their work. The unmarried Newton (1642–1727), known as "the reclusive Cambridge don," was "never at rest," according to Richard Westfall, who also gave this title to his biography (1980). Radical innovators in science and the arts not only demonstrated a basic incompatibility between marriage and work. Some of them also clarified this personal dilemma in letters and diaries.[47] In the summer of 1838, Darwin, still single, made pencil notes on the back of a letter setting out in parallel the pros and cons of marriage (notes which his granddaughter Nora Barlow saved and included at the end of a later edition of Darwin's autobiography).[48] He opted for marriage, but neglected to mention in his autobiography that his father was only willing to continue supporting him financially if he got married. Darwin complied with the request and decided to ask his cousin Emma, a daughter of his mother's brother, whom

he had known since childhood. They were not in love, but did like each other. Their union was considered a marriage of convenience, far from uncommon among the gentry, not least because it kept property within their class.[49] Darwin's marriage resulted in no fewer than ten children, of whom eight survived childhood.

The priority (among scientists) of being unmarried and not being part of a family is implied in the remarks made by the historian of science W. I. B. Beveridge about examples of "unparalleled" excitement after a new discovery or breakthrough: "The scientist seldom gets a large monetary reward for his labours . . . But the greatest reward is the thrill of discovery. As many scientists attest, it is one of the greatest joys that life has to offer."[50] In his autobiographical account, Watson, twenty-five years old and unmarried, describes his excitement after their discovery of the double helix structure of the DNA molecule, the copying mechanism responsible for the transmission of genetic material from one generation to the next: "my morale skyrocketed . . . Even more exciting, this type of double helix suggested a replication scheme much more satisfactory than my briefly considered like-with-like pairing."[51] An account of Einstein's discovery of special relativity in 1905, which he had worked on in his free time for more than seven years, tells us:

> The discovery was without doubt Einstein's most intensive experience. The five weeks he needed to work out his find and make it ready for the press were a happy time with sensations of the highest joy. He was speechless. To his colleague Sauter at the Patent Office, where he worked full-time six days a week, he repeatedly said only: "My joy is indescribable."[52]

As indicated in the epigraph for this book, the approach followed here assumes that, to have historical effect, a person must be in a position to do so, arising from their place in sets of social relationships – institutional, conjunctural, or both. The history of science, however, deals more with science than its practitioners. Their *work* has a central place and is spelled out in great detail. Their *life* hardly gets any attention at all. It is assigned to the genre of the biography, in which a chronological, descriptive account is favored over a comparative, analytical approach. Chapter titles of important textbooks carry the big names in science, describe the work of these pioneers, and place it in the framework of intellectual history, but tell us little or nothing at all about their life. As the history of ideas, the history of science has long remained a disembodied science. In a concise biography of Darwin, one of the authors draws attention to this trend or practice,

which is certainly not absent in the genre of biography: "In the first half of the twentieth century people studied Darwin primarily as a thinker who had 'forerunners' and whose ideas were 'revolutionary' or were 'in the air.' His life was considered as an episode of intellectual history."[53]

The standard work of I. Bernard Cohen, *Revolution in Science* (1985), running to more than 700 pages, is a striking example of this common practice. The chapters are named after the revolutionary scientists, including the usual suspects, Copernicus, Kepler, Galileo, Descartes, and Newton, without a single word about their life and therefore nothing either about the relationship between the life and the work.[54] Yet the author does have a strong opinion on the subject. One of his so-called revolutions in science concerns a change in the scientific enterprise at the end of the nineteenth century: from scientists who worked more or less independently, with limited scientific means, to a structure in which research was organized in teams, initiated and controlled by scientific societies and institutions, universities, research institutes, and committees. According to Cohen, this development made "single performances" in science out of date.[55] As will be shown, this allegation should be seriously doubted.

Cohen's point of view ignores at least ten cases of recognized great twentieth-century breakthroughs from pioneers who carried out their research independently and with limited means and without close relationships with mentors at universities or research institutes. We are talking about scholars of the magnitude of Freud, Weber, and Einstein. As mentioned above, they changed the directions in three different areas of research at the beginning of the twentieth century. Some years later, meteorologist Wegener (1880–1930) single-handedly, and operating similarly on the margins of the academic world, formulated his theory on the origins of continents and oceans (later called continental drift). The first version appeared in 1915 and drew little attention. In the late 1920s, a revised English version of Wegener's theory was finally dismissed by an international conference of geologists because of lack of evidence. It was only half a century later, following research on ocean floors, that Wegener's theory found support and brought about a revolution in the earth sciences.[56] Wittgenstein (1889–1951) preferred to work in isolated locations in a self-imposed exile and twice effected a reversal in the philosophy of language: first with the *Tractatus* (1922), which was also called a work of art, and later with his similarly aphoristic *Philosophical Investigations* (1953) in which he propagated a more anthropological approach with his notion of language games.[57] One

of his friends in Cambridge, Keynes (1883–1946), who had not formally studied economics but had informally followed lectures in this field and had much practical knowledge at his disposal, wrote *The Economic Consequences of the Peace* (1919) and *A General Theory of Employment, Interest, and Money* (1936) and became the most influential economist of the century, called "the father of macroeconomics."[58] In 1953, at the Cavendish Laboratory in Cambridge, Watson and Francis Crick discovered the double-helix structure of the DNA molecule in a race with colleagues at King's College in London and the American chemist Linus Pauling, who had come close to the solution but had to drop out for personal reasons. Their discovery of the "secret of life" would bring about a revolution in microbiology and result in three Noble prizes. It was one of the great discoveries of twentieth-century science and has had great effects on our lives in many ways.[59]

Without any academic education, but as protégée of paleontologist and anthropologist Louis Leakey, who supervised her at a distance from his museum in Nairobi and provided feedback, Jane Goodall studied the behavior of chimpanzees in the wilds of Gombe (Tanzania) in the early 1960s. From her long-term fieldwork with participant observation – a new departure in her discipline – she established that these primates had more in common with humans (fabrication and use of tools, eating of meat, social skills) than was generally assumed. Her breakthrough in the study of primates earned her the title of "the woman who redefined man."[60]

Evolutionary biologist and geneticist Hamilton (1936–2000) investigated social altruism among insects, and the question of how to fit altruism into Darwin's theory of natural selection (the struggle for existence) as the mechanism of evolution. Hamilton was a graduate student at the London School of Economics without the usual supervision of a tutor because of the unpopular subject (genetics and behavior). In 1963 he published two pioneer articles in which he coined the key concept of "inclusive fitness" (later called "group selection") and put his finger on the genetic mechanism which – as a correcting completion of Darwin's discovery of natural selection – helps explain altruism and self-sacrifice between close relatives.[61] Hamilton's theory is still contested, though his work has become widely known and accepted since the publication of sociobiologist Richard Dawkins's *The Selfish Gene* (1976).

In 2002 the Russian mathematician Perelman (1966–) found the proof for "Poincaré's Conjecture." This achievement in geometric topology is considered the mathematical breakthrough of the