A Scientific Approach to the Shakespeare Authorship Question

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Abstract
In the field of science, it is widely accepted that all hypotheses and theories can, and should, be tested. Here, we treat the authorship of the works attributed to William Shakespeare from Stratford-upon-Avon as a hypothesis (rather than received truth) and review the current methods available for testing this hypothesis. Justification for this investigation arises from the recent identification of several of Shakespeare's coauthors. To illustrate potential approaches, we compare the widely accepted Stratfordian hypothesis with other competing hypotheses (authorship candidates), mainly referring to the case for Henry Neville (1562-1615). First, we identify important components of the scientific method as applied to the Shakespeare authorship issue: evaluation of evidence, formulation of a hypothesis, testing the hypothesis, and rejecting or revising the hypothesis. Referring to historical examples, we show how the scientific method has produced precise, dependable advances, even though the way in which it proceeds is often messy. Crucial for science's progress is confirmation of experimental results, and discussion (with peer review) by the community of scientists before any hypothesis gains general acceptance. Second, using the example of Neville as a candidate, we provide specific examples of application of these principles to factors such as a candidate's social networks, access to privileged knowledge, and textual analysis; we comment on the strengths and weakness of each approach, and how they might be applied in future studies. Throughout, we stress how doubt is an essential ingredient of progress not only in science but also in knowledge generally, including the Shakespeare authorship debate.

Keywords
Shakespeare, authorship debate, scientific method, scientific revolutions, evaluating evidence, hypothesis testing, peer review, control experiments, false positive results, Bayes theorem

Introduction
There is currently a consensus, among both literary scholars and the general public that William Shakespeare, or Shakspere,¹ (1564-1616) from Stratford-upon-Avon, England, was the Bard. This belief is founded on tradition and on many cues in the environment that reinforce it. For example, commentaries by English literature experts on Shakespeare, which are frequently carried by the media, invariably rest on this assumption. However, much current evidence does not support this opinion. For example, as Diana Price (2012, pp. 309-322) has demonstrated, there is no contemporaneous literary evidence linking William from Stratford to the Bard by documents such as correspondence, personal relationship with a patron, or death notice, despite centuries of investigation. Such absence of evidence becomes significant when a similar test is applied to 24 writers who were the Bard’s peers; every one demonstrated a literary paper trail. Similar lack of evidence extends to all aspects of William from Stratford’s literary life and is manifest in the many biographies of Shakespeare by the need for authors to frequently use expressions such as “probably,” “must have,” “surely did,” and many similar phrases that leap the evidence gap.

What might appear to be strong evidence for William from Stratford’s authorship of the plays is that the name “William Shakespeare” appears on some quartos and on the First Folio. However, for 8 years, c1590-1998, no play was attributed to William Shakespeare (although two long poems were published as by him in 1593 and 1594). Furthermore, Shakespeare’s name appears on other plays and poems that are now attributed to other writers. Thus, as Barber (2015) pointed out, “The name ‘William Shakespeare’ being on the title page, Stationers’ Register or dedication is not sufficient to establish authorship” (p. 62). At the time, it was not socially acceptable for nobility or gentry to write for the public, and there was no tradition of writing for the stage. The only way to accommodate these facts is to look carefully at the evidence provided by the plays themselves.

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theater. Therefore, the name “William Shakespeare” could either have been a nom de plume or was the name of an intermediary—a “front man” (Pointon, 2011; Price, 2012, p. 60). The use of such a name would not only protect the identity of a man from a prominent family but also leave him free to write anything he wished, including material that could have attracted scandal.

The discrepancies between the conventional view that William from Stratford wrote the works ascribed to Shakespeare and extant documentary evidence has led to the Shakespeare authorship debate. What would scientists make of this?

A central tenet of scientific research is that our knowledge is incomplete and that even the most plausible and widely accepted hypothesis can, and should, be tested. It therefore comes as a shock to scientists to encounter the resistance by most English literature departments to test the hypothesis that the body of work ascribed to William Shakespeare was authored by William from Stratford. Thus, very few English departments worldwide will allow PhD research into the Shakespeare authorship issue, despite the lack of reliable evidence about William from Stratford (Barber, 2015) and the growing body of evidence in support of other authorship candidates (Leahy, 2018). Many Shakespeare academics express the view that there is no doubt that the man from Stratford wrote the works, insisting that they do not consider this a hypothesis, but rather a proven fact. This stand strongly contrasts with the approach of the scientific community, prompting the Oxford physicist Roger Penrose (2016) to conclude his book on changing theories in physics by writing about the Shakespeare authorship issue:

> No matter how difficult it may be to shift a scientific viewpoint that has become generally established, it would seem that to do the same in the literary world—particularly for such a firmly entrenched dogma with huge commercial interests—would be simply vast by comparison! (p. 395).

Some may argue that works of literature are not accessible to analysis using the scientific method. Does this apply to the Shakespeare authorship issue? For centuries, we have lived with the concept of two cultures: the arts and sciences. The arts are the creative representation of reality through metaphor, story, image, and pattern. The quality of the arts is tested by time and opinion. However, knowledge of the historical background from which great artists emerge, and which underpins their achievements, belongs to epistemology, which studies the reliability of knowledge, and is therefore accessible to the scientific method.

In the first part of this article, we will identify important components of the scientific method as applied to the Shakespeare authorship issue: evaluation of evidence, formulation of a hypothesis, testing the hypothesis, and rejecting or revising the hypothesis. The second part illustrates specific examples of each of these components of scientific analysis. We will consider two main hypothetical candidates: William from Stratford (the Stratford hypothesis) and Henry Neville (1562-1615), who served as Ambassador to France and as a member of Parliament (the Neville hypothesis). Although several other individuals, including Bacon, De Vere, Marlowe, and Sidney, are currently considered as authorship candidates (Leahy, 2018), we mainly focus on the case for Henry Neville, which has been laid out in several recent books, and which also discuss why, and how, Neville may have attempted to remain anonymous (Bradbeer & Casson, 2015; Casson & Rubinstein, 2016; James & Rubinstein, 2005). We have chosen Neville because, at present, his case seems as strong as any other authorship candidate: His life fits the orthodox chronology of Shakespeare’s works; he was well educated and traveled to Italy; he was friends with courtiers and playwrights associated with Shakespeare; the trajectory of his career fits the subjects of the plays; and there is a literary paper trail from Neville to the Bard (Casson, Rubinstein, & Ewald, 2018; Rubinstein, 2013). Nonetheless, our approach could also be applied to any of the other authorship candidates.

Evaluating Evidence

Weighing evidence is one of the great challenges in applying the scientific method to study unknown phenomena. In reviewing newly reported experimental findings, the community of scientists pays great attention to the reliability and reproducibility of the methods used for making measurements. When addressing the Shakespeare authorship issue, the quality of evidence (e.g., an original document written by the author versus a facsimile, or hearsay) is most important (Barber, 2015). What types of evidence are available in researching the Shakespeare authorship question? Conventionally, evidence is divided into internal (focusing on the text of the Shakespearean canon) and external (such as historical records and timelines). Internal evidence has traditionally been viewed as weak, and some scholars even choose to disregard it completely. The Oxford physicist David Deutsch (2011) has pointed out how narratives are often open to many interpretations, making them poor hypotheses. In contrast, modern statistical analysis of the Bard’s word choice has brought a new rigor to textual analysis (Egan, 2017).

Here we identify different types of evidence to support, or refute, hypotheses based on their currently perceived strength, acknowledging that some readers will disagree with us, and that future research developments (such as newly discovered documents or the application of modern forensic methods) may radically change these perspectives.

1. Evidence based on a candidate’s social network. Perhaps the weakest form of evidence in support of a hypothetical candidate concerns records indicating that there were relationships between the candidate and other individuals pertinent to the authorship. For example, whoever Shakespeare was, it appears possible that he knew John Fletcher with whom he cowrote
the last three plays. It also appears possible that he knew Henry Wriothesley, the 3rd Earl of Southampton to whom he dedicated his poems. In addition, he may possibly have known the Earls of Pembroke who became the dedicatees of the First Folio. No evidence exists documenting contacts between William from Stratford and Fletcher, or the Earls of Southampton or Pembroke. In contrast, Henry Neville knew all these people and many more: We have documentary evidence for these relationships. Nonetheless, this cannot be regarded as particularly strong evidence as the circle of individuals pertinent to the Shakespeare authorship is relatively small, and many were related through marriage. Many people would have social relationships in this network and it would not necessarily make them likely to be the author of the Shakespearean canon. Thus, the chances for coincidence and “false positive” associations are high. Unfortunately, the possibility of coincidence accounting for apparent connections between persons and events in their lives and the text (especially the sonnets) is often overlooked, although it is being increasingly recognized as a confounding factor in scientific studies (Hand, 2014; Kahneman, 2011). An important related issue is that correlation does not imply causation; for example, frequently reported associations between certain environmental factors and health disorders do not prove that the environmental factors caused the health disorders. To interpret the association of two factors as demonstrating a cause-and-effect relationship is a logical fallacy, known as cum hoc ergo propter hoc, or “with this, therefore because of this.” Similarly, evidence that Edward De Vere, the Earl of Oxford, and Henry Neville both knew William Cecil, Lord Burghley, is suggestive: They both had privileged knowledge of Cecil and so might have modeled Polonius in Hamlet on him. However, such an association does not prove that either Oxford or Neville was the Bard. In such cases, prospective experimental tests are required, which are described in the sections below.

2. Evidence based on privileged or expert knowledge. Stronger evidence for an authorship candidate consists of documentation that the Bard had access to information available to only a few individuals. One example is detailed knowledge of local geography of northern Italy, such as the canal system for transportation that is evident in Two Gentlemen of Verona (Roe, 2011, pp. 35-61); such knowledge suggests personal visits. Thus, while Neville spent several months in northern Italy (James & Rubinstein, 2005), there is no evidence that William from Stratford did. Less compelling, but still important, would be evidence of education and expert knowledge of subjects that are implicit throughout the plays, such as proficiency in modern and classic languages to access source material, as well as familiarity with the law, politics, falconry, and astronomy. There is good evidence that Neville was especially knowledgeable in all these areas, but the grammar school teaching available in Stratford would not have provided such education (e.g., modern French or Italian languages).

3. Evidence based on textual analysis had been dismissed by some as biased and subjective, yet stylistometry—the computer-based, statistical analysis of word frequencies and conjunctions—now constitutes one of the strongest lines of evidence (Craig & Kinney, 2009; Egan, 2017). This approach rests on a strong foundation of the neuroscience of linguistics (Pinker, 2007). By analyzing either semantic or function words, used separately or in combination, it has been possible to identify authors with a high degree of statistical significance (typically with \( p \) values < .0001, Craig & Kinney, 2009, p. 29). The validity of the method has been confirmed by analyzing large data sets and by applying appropriate control tests and seems likely to substantially aid identification of authorship candidates. These analyses have identified Christopher Marlowe as a coauthor of the Henry VI plays, and Marlowe is now credited as a coauthor in the New Oxford Edition (Taylor & Egan, 2017). However, not all authorities agree (Rudman, 2016), and further confirmatory studies by independent research groups will be required before a consensus is reached. So far, such modern textual analyses have not been applied to Henry Neville.

Using Evidence to Formulate a Hypothesis

Despite science’s insistence on established facts and reliable evidence, imagination and creativity have played a significant role in the advancement of knowledge during the formulation of hypotheses. As Einstein put it in 1929, “Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution.” Imagination is not necessarily the enemy of research or science: Indeed, it can occasionally be the prophetic ally. Alexander Pope (2003) writing in 1732-1734 asked, “What other planets circle other suns?” Thus, he anticipated discoveries made with modern telescopes.

The development of any hypothesis—such as a specific Shakespearean authorship candidate—should be based on a careful and critical evaluation of the body of evidence. However, this was not always the case and the history of science shows how hypotheses grew out of beliefs that enabled early scientists to deal with observations that could not be explained. They provided guesses to explain poorly understood phenomena such as the night sky, drawing on logic but eschewing experimental tests. So, for example, the ancient Greeks developed the idea of the ether, through which light
traveled, a notion which persisted into the early 20th century. A crucial development occurred when such suppositions were no longer treated as beliefs but became hypotheses that were tested experimentally, notably by members of the Royal Society (Ball, 2014). Although this approach of experimentally testing hypotheses, championed by Francis Bacon, was initially derided as “conjuring,” its success in advancing knowledge soon established itself (Deutsch, 2011).

One problem that sometimes arises from this crucial component of the scientific method is that individuals who have developed a hypothesis may become overly attached to it in the face of conflicting evidence, especially if the hypothesis appears to explain the otherwise unknown. An example is Fred Hoyle’s continued belief in his Steady State theory for the universe in the face of strong evidence for the Big Bang theory (Livio, 2013). Max Planck, the founding father of quantum mechanics, warned in 1906 that “new scientific truth does not triumph by convincing its opponents and making them see the light but rather because its opponents eventually die, and a new generation grows up that is familiar with it” (p. 686). This and other aspects of the way that the scientific community deals with experimental tests of hypotheses are discussed in the next section.

One potential flaw in developing a hypothesis for a specific Shakespeare Authorship candidate is that evidence accrued in support of that candidate is then assigned as a standard that any other candidate must meet. For example, the evidence that John Fletcher (who coauthored later plays with the Bard) knew and admired Henry Neville might become a factor for evaluating other hypothetical candidates—who would also be expected to have evidence of a personal relationship with Fletcher. However, other possibilities exist, such as Fletcher being asked to complete drafts of plays by a deceased playwright (e.g., Edward De Vere). This danger of applying “reverse-engineering” requirements for other candidates can be avoided by applying appropriate testing for each candidate hypothesis.

Are there any general guidelines to follow in developing an authorship-candidate hypothesis? One general rule is that a plausible hypothesis does not require revisions or reinterpretations to be made to the accepted historical record. For example, Edward De Vere remains a popular Shakespearean candidate, but his death in 1604 requires a redating of subsequent plays, such as Macbeth and The Tempest, which may contain references to events that occurred after De Vere died. Alternatively, another author could have contributed to those plays, or the conventional dating of the plays may be in error (Barber, 2015; Kilvary, 2010). A useful approach to judging the plausibility of any hypothesis has been developed by Manley and MacLean (2014), drawing on suggestions by Schoone-Jongen (2008):

1. the possible: a hypothesis which no evidence flatly contradicts;
2. the plausible: a conjecture based on some sort of positive evidence, rather than on the absence of negatory evidence, but not strong enough to rule out other possibilities;
3. the probable: a hypothesis enabling other possibilities to be laid aside because the probable hypothesis is much stronger than any alternatives;
4. the demonstrably certain. (However, most scientists would not regard any hypothesis as certain but, rather, highly probable due to extant documentary evidence, as discussed in the next section.)

Inherent in Manley and MacLean’s approach is the concept of probability and uncertainty that are embraced by modern science. A well-known example is the uncertainty principle of quantum mechanics, which recognizes that it is impossible to precisely measure certain pairs of physical properties of atomic particles (e.g., position and momentum). Scientists in all fields recognize the inherent uncertainty in their hypotheses. A ranking scale such as that of Manley and MacLean’s, or a quantified refinement of it, could be used to reevaluate hypotheses, after they have been tested, a topic that we discuss next.

Testing Hypotheses

In most branches of science, experimental tests focus on novel predictions of a hypothesis that extend beyond the data set used to formulate that hypothesis. In some fields of study, the range of possibilities for testing such novel predictions are restricted by the limits of available knowledge. Thus, the Shakespearean authorship issue is not readily accessible to experimentation, but depends on evaluation of extant data, such as the texts and historical records.

Although much evidence (apart from textual analysis) cannot be easily quantified, application of a ranking system such as that suggested by Manley and MacLean, or an estimate of the probability of each piece of evidence being correct, can be attempted. The latter approach has been used by Peter Sturrock (2013) who tested three hypotheses (candidates): William from Stratford, Edward de Vere, and another unknown candidate whom he called “Ignotus.” Sturrock made probability estimates of the reliability of each of several pieces of evidence. He then combined the probabilities of all the evidence considered, using Bayes theorem to test the three hypotheses. Such an approach is valid if each piece of evidence is independent of others (Egan, 2017, p. 45). His statistical analysis showed De Vere was a more likely candidate than William from Stratford to have been the Bard. However, his approach took the form of a fictional narrative and side-stepped the challenge of weighing evidence by asking fictional characters in his narrative (who included a Stratfordian and a skeptic) to guess the odds of each piece of evidence being correct. He also did not consider Neville as a candidate.

An experimental result that is in conflict with a generally accepted theory often prompts questions about the validity of
the experimental methodology. Thus, when Galileo reported that Jupiter had moons that changed in their position, a finding inconsistent with the prevailing view of a fixed, unchanging heavens, some of his contemporaries questioned the accuracy or validity of his telescopes (Bucciantini, Camerota, & Giudice, 2015). Did the telescope actually show what it was purported to show? Experimental tests are more likely to be valid when they are repeated by different investigators and the results are found to be consistent, and when they are supported by other tests using different valid methodologies. Galileo’s observations were eventually confirmed, but it was only after acceptance of the heliocentric theory of the solar system that they could make sense and become widely accepted. Thus, although experimental tests are a central component of the scientific method, their results should not be accepted uncritically or without considering the framework of hypotheses that are being tested.

Another important aspect of testing of hypotheses is the inclusion of controls. A well-known example of a controlled experiment concerns the inclusion of a placebo in clinical trials of new drug treatments. A good example of this approach in the Shakespeare authorship issue is the work of Diana Price (2012), which was alluded to above. She looked for but found no evidence for a literary paper trail for William of Stratford. Her control experiments consisted of applying the same test to 24 writers who were the Bard’s peers; she demonstrated a literary paper trail for each and every one. This different result for testing the Stratfordian hypothesis versus her control hypotheses (24 of the Bard’s peers) strongly supports the validity of her result and is discussed further in the next section.

**Rejecting or Revising Hypotheses: Scientific Revolutions**

When the results of an experimental test agree with the predictions of a hypothesis, although important, it does not mean that the hypothesis is proven. Rather, the hypothesis is simply supported by the results. The history of science is replete with examples of how an apparent confirmation of the prediction of a hypothesis has led to acceptance of that hypothesis by the community, leading to a wrong turn in subsequent research. For example, to explain the anomalous behavior of the orbit of Mercury, 19th-century astronomers looked for evidence of a planet “Vulcan” close to the sun that might perturb Mercury’s orbit (Levenson, 2015). Sometimes they reported seeing it, which would have confirmed Newtonian predictions; at other times, the existence of Vulcan could not be confirmed. However, after Einstein developed his General Theory of Relativity, which modified Newtonian concepts of gravity, there was no longer any need to postulate the existence of Vulcan.

Karl Popper (1959) proposed that any scientific hypothesis should be accessible to falsification—or else it is nonscience or dogma. Falsification of hypotheses remains an influential criterion in the scientific community. Diana Price’s experimental tests for literary paper trails, described above, might constitute a falsification of the Stratford hypothesis. Nonetheless, one experimental failure of the predictions of a hypothesis does not necessarily mean that it is doomed, because the methodology itself might have been unreliable (though this is less likely when the experiment is repeated and compared with results of control experiments, and is confirmed by other approaches). The nature of science is that when the predictions of a hypothesis consistently fail, or a rival hypothesis explains experimental results much better, then a consensus or “paradigm shift” occurs among the community of scientists and they adopt the new hypothesis. Sometimes this process takes time and is painful, a good example being the scientific revolution that occurred when Copernicus’ ideas challenged the system of astronomy based on the assumption that the sun and other planets rotated around the earth. Not until a century later, when Newton explained how gravity accounts for the elliptical orbits of planets discovered by Kepler, did the general community of scientists accept the Copernican heliocentric theory. Thus, as Thomas Kuhn (1962) noted, scientific revolutions, unlike political revolutions, are often slow. Sometimes a hypothesis is rich enough that it can be modified to account for new findings and remain a robust vehicle for more than a century. A good example is Darwin’s theory of evolution, which has been tested, directly or indirectly, thousands of times, using multiple different approaches and methodologies, by a broad range of scientists from paleontologists and archeologists to geneticists. Over the course of time, Darwin’s original proposal has been modified and expanded to account for experimental results; for example, he was unaware of the role of genes in heredity. The result is a widely accepted theory that guides much of present-day biological research and that is still being improved. Indeed, the way that science progresses has similarities to a Darwinian “survival-of-the-fittest” process, with the successful (most fit) hypotheses being those that survive experimental testing by the scientific community, and with evolution occurring as hypotheses are modified (mutated) over time.

Strong hypotheses are much more than a model that accounts for the available evidence. Imre Lakatos (1978) pointed out that a hypothesis becomes important when it suggests novel possibilities, not previously considered, that can be experimentally tested. For example, Einstein’s General Theory of Relativity predicted the presence of gravitational waves in the universe which were confirmed a century later—when the experimental technology became available (LIGO, 2016). Thus, when considering any Shakespearean authorship hypothesis, we should look for evidence that the hypothesis suggests, but which was not considered during the formulation of that hypothesis. For example, although not usually considered, given the number of songs in the plays, one might investigate whether there was evidence to support the view that a specific candidate showed expertise in music.
Another aspect of hypothesis testing is that evidence once used to test one hypothesis may later become relevant for testing a new hypothesis. Thus, Michelson and Morley’s 1887 experiment indicated that the speed of light was the same, whatever its direction with respect to the direction of flow of the ether, as the Earth moved through it, baffling the community of physicists. Only after Einstein proposed the Special Theory of Relativity (which states that the speed of light in a vacuum is constant) did the results of the Michelson-Morley experiment make sense. One example concerning the Shakespeare authorship debate is the Northumberland Manuscript, discovered in 1867, which was first used as evidence to support the candidacy of Francis Bacon, whose name appeared on it. The Northumberland Manuscript is a folder that contains numerous manuscripts including political and theatrical texts, lists the plays Richard II and Richard III, and quotes from The Rape of Lucrece. Neville’s surname appears at the top of the folder and Burgoyne, who in 1904 wrote the first major report on the documents, suggested it belonged to a member of the Neville family, most probably Henry Neville (although, at the time, Neville had not been proposed as an authorship candidate). Thus, the Neville hypothesis can account for the data extracted from the Northumberland Manuscript equally well as Bacon or any other candidate nominated so far.

An important component of the process of evaluating hypotheses is the scientific community itself, comprising a large number of individuals with divergent views, who compete with each other for fame and financial support of their research. Peer review by this community, usually in the form of anonymous critiques of research submitted to journals, has proven a robust (although not infallible) method of advancing knowledge since it was introduced in Philosophical Transactions of the Royal Society in 1665. Note that although expert opinion is an important resource for the scientific community, it is collective wisdom that is the real guarantor of progress. Each new generation of scientist brings along new ideas.

To summarize: Science proceeds from evidence of a problem, develops a question, gathers data, forms hypotheses, conducts experiments, gathers further data, analyses the new data, and comes to a tentative conclusion. Hypotheses are attempts to explain the data and these are superseded or revised when new evidence emerges. A paradox of science (Singham, 2019) is that although it produces precise, dependable knowledge (e.g., such as that necessary for the development of novel technologies like smartphones, spacecraft), the method by which it proceeds is often messy. Philip Ball (2014) has written that science works “because it can make mistakes, follow blind alleys, attempt too much—and because it draws on the resources of the human mind, with its passions and foibles as well as its reason and invention” (p. 285).

Specific Examples

Evidence Based on a Candidate’s Social Network

As noted above, this may be regarded as the weakest type of evidence, but we will provide some examples to illustrate how it could be used to test candidate hypotheses; we mainly focus on Neville and William from Stratford. As we proceed, we will apply the scheme modified from Manley and MacLean (possible, plausible, probable, highly probable—terms discussed above) to evaluate how likely each proposal is.

Family relationships. Many scholars have linked an authorship candidate to characters in the plays, and it is certainly possible to do this for Neville. For example, there are many apparent references to Henry Neville’s family members in the history plays (Bradbeer & Casson, 2015). The weakness of this approach, however, lies in the increased possibility of coincidence when multiple comparisons are made—in such cases the chance of “false positive” results increases (Hand, 2014). Thus, applying the modified scale of Manley and MacLean, these references can only be described as possible.

Relationships with other playwrights and courtiers. In these cases, the historical record improves the reliability of lines of evidence. Thus, it is highly probable that Neville traveled with Walsingham to Scotland in 1583 (Eedes, 1622), the very year the latter established the Queen’s Men (James & Rubinstein, 2005). It is therefore possible that a young educated courtier might be invited to join Walsingham’s theater project (along with George Peele and Christopher Marlowe). Neville’s father and grandfather had been involved in court entertainments and Neville had an interest in theater as is shown by his annotated books. It is therefore plausible that he may have started writing for the Queen’s Men with Peele who wrote the first version of King John and who cowrote Titus Andronicus (Bradbeer & Casson, 2015, p. 13). Peele and Neville were both at Oxford at the same time and, in 1593, Peele wrote fondly of his time hunting and hawking at Windsor where the Nevilles were responsible for the deer park (Vickers, 2002, p. 171). Neville’s father died in January 1593, so references to hunting would possibly to have been with Henry Neville himself.

Venus and Adonis was published in 1593; as previously noted, it is highly probable that Neville’s father died in January that year (Fuidge, 2010), so it is plausible that Neville felt free to publish under a pseudonym as he could not embarrass his father. Neville’s next son, born in 1596, was named William. This name might be thought of as just a coincidence but for the fact that the next son, born in 1602 when Neville was in the Tower, was named Edward, possibly in memory of Neville’s grandfather who was buried in the Tower chapel where we can be sure Neville attended worship regularly. It is plausible that the names Neville chose for his
children had some significance. His son Robert was christened in 1604 (after Neville’s release from the Tower) and his godfather was Robert Cecil. At the time Neville was grateful to Cecil for saving his life and expressed his gratitude in an extant letter. The Bard also chose the names of his characters with care. Several significant Shakespeare character’s names are also names of Neville’s children. In contrast William from Stratford named his daughters Susanna and Judith yet the Bard never named any character Susanna or Judith.

In contrast, because of a lack of data, the social contacts of William from Stratford are, at best, in Manley and MacLean’s category of possible, even though the word probable is commonly applied by biographers to leap the many evidence gaps that they must confront. For example, when they write that William “probably” spent time in noblemen’s libraries to read all the books he must have read to write the plays; he “probably” served as a school master in the country; he “probably” had legal training; all these are merely possible. Historical research and critical thinking has not been applied to William from Stratford in the same way that it has to other authorship candidates. It is time to avoid this double-standard by applying scales, such as that of Manley and MacLean equally to evidence for William as well as other Shakespeare candidates. For example, while there is no evidence that William from Stratford spent time in a nobleman’s library reading the sources for the plays, Neville left a library of books, some with his name inscribed in them, and many annotated with passages underlined and notes relevant to the Shakespeare plays (Casson & Rubinstein, 2016, p. 8).

Evidence Based on Privileged or Expert Knowledge

Many scholars have questioned where William from Stratford gained his knowledge of so many fields, including law, classical learning, the royal court, seamanship, military matters, medicine, and so forth (Michell, 1996, pp. 20-35; Regnier, 2013; Showerman, 2013). We have chosen four such areas to explore in this context.

Music. We have already mentioned that any hypothesis should be tested by addressing new questions that were not part of the original data set used to develop that hypothesis. One example is whether a specific candidate showed expertise in music, as the Bard did (Wilson & Calore, 2014). In Neville’s case this is possible. He owned a lute and grew up in a household where music was important, indeed a household where at least one composer lived. Neville’s step-mother’s maid married Thomas Morley. He composed the music for It was a lover and his lass, a song in As You Like It. Morley was a pupil of William Byrd who gave a book of keyboard music to Lady Neville in 1591 (Harley, 2005). The manuscript was completed in Windsor. At the time Lady Neville was living at Billingbear near Windsor. There is no such documented evidence of expertise in music, or relationships with musicians, for William from Stratford.

Astronomy. The Bard also demonstrated specialized knowledge of astronomy (Falk, 2014; Rowan-Robinson, 2010). Shakespeare declared in sonnet 14, “I have astronomy.” Although he is using this metaphorically, we can reasonably presume he had some knowledge of astronomy because of other instances where this knowledge is implicit or overt. It is possible that the star in Scene 1 of Hamlet is the new star (supernova) reported by Tycho Brahe in 1572, which had become the talk of European courts (Falk, 2014, p. 146). Although Shakespeare’s astronomy is mainly Ptolemaic, he seems to be aware of the Copernican revolution that was underway and appears to have been influenced by leading astronomers of his day. Thus, he was aware of the problems that the orbit of Mars posed for the Ptolemaic theory, with its apparent reversed direction of motion in the sky for several weeks each year (Helen uses this “retrograde” motion of Mars to tease Paroles in All’s Well That Ends Well, Act 1, Scene 1, lines 164-177). It has been suggested the four ghosts around Jupiter in Act 5, Scene 4 of Cymbeline were prompted by Galileo’s 1610 discovery of four moons revolving around Jupiter (Falk, 2014, p. 205). The earliest recorded performance of this play was 1611. There is some evidence to suggest the Bard was aware of the concept of an infinite universe (Falk, 2014, p. 163). If so, this raises the question, “From whom did he obtain this specialized knowledge?” More specifically, does the evidence concerning accessibility to novel astronomical concepts support one hypothetical candidate (e.g., Neville) better than another (William from Stratford)?

The idea of an infinite universe was promoted by Giordano Bruno and Thomas Digges. Thomas Digges also observed Tycho’s supernova. He knew John Chamber and Henry Savile (both of whom were friends of Henry Neville) as they worked together on a government commission about whether to adopt the Gregorian calendar. Digges’ mother-in-law was Ursula Neville, daughter of Henry Neville’s great uncle, George fifth Baron Bergavenny (who appears as Abergavenny in Henry VIII). Leonard Digges, his son, contributed verses to the First Folio. Leonard’s brother, Dudley, was, like Neville, a Member of Parliament and an investor in the second London Virginia Company. Anne St. Leger, their mother, later married Thomas Russell, overseer of William of Stratford’s will. Russell’s half-brother, Henry Berkley, married Neville’s daughter Elizabeth in 1608 (James &Rubinstein, 2005, p. xviii). Anne Dudley (née Russell), Countess of Warwick, sold a cottage in a garden in Stratford-upon-Avon to William Shakspeare in 1602. Her brother, John, married Elizabeth Cooke, Neville’s mother-in-law’s sister. These interlocking relationships tantalize us, showing opportunities for both Neville and William of Stratford to have access to the opinions of astronomers, with the possibility of
a link between these two authorship candidates. Thus, access to this specialized knowledge is not circumscribed enough for it to be decisive in tests of our two hypothetical candidates.

Did either Neville or William of Stratford have an education that would have promoted an interest in astronomy in general and the Copernican revolution in particular? Henry Neville studied astronomy under his Oxford tutor, Sir Henry Savile. John Chamber praised Neville as an astronomer in 1600 (Casson & Rubinstein, 2016, p. 108). Neville annotated books on Ptolemaic astronomy and these can still be seen at Merton College and in the Neville library at Audley End. Savile, a lifelong friend with whom Neville stayed in touch, making him a trustee of his will, had a copy of Galileo’s 1610 book Siderus Nuncius, in which the discovery of Jupiter’s moons was announced (and, as stated above, might be reflected by the four ghosts circling Jupiter in Cymbeline). Savile was a leading Greek scholar, mathematician, and astronomer who took the young Neville on a tour of Europe. Between 1578 and 1582, they traveled to Paris, then to Strasbourg, through Germany, on into Poland and eventually through Vienna to Northern Italy.

One of Savile’s aims on the tour was to meet European astronomers, principal of whom was Tycho Brahe. Tycho’s observatory was, from 1576, on an island within sight of Elsinore (Christianson, 2000). As noted above, Tycho made observations of the new star (supernova) of 1572 and this celestial phenomenon is believed to be the star mentioned in Hamlet (1.1.34). Tycho studied at Wittenberg University where Hamlet had been for his education. Johannes Praetorius, professor of astronomy at Wittenberg in 1571 and, from 1576, professor of mathematics at Altdorf (where Savile and Neville met him) wrote a study of comets in 1578. Savile, who also studied comets, corresponded with him from 1581. (Shakespeare refers to comets from the earliest plays.)

Wittenberg lies between Denmark and Prague where Savile and Neville met the astronomer Tadeáš Hájek, a friend of Tycho’s. In 1581, they were in Wrocław (Breslau) Poland, where they met Paul Wittich, an astronomer who had been a student at Wittenberg and had recently visited Tycho in August-November 1580 (Christianson, 2000, pp. 379-381). Savile made notes on Wittich’s thoughts after that visit (Goulding, 1995, p. 152). Poland is referred to three times in Hamlet. In 1590, Tycho sent copies of his portrait to Savile’s brother, Thomas, which included references to his ancestors Rosencrantz and Guilderstern. Finally, the specified location of the star in Scene 1 of Hamlet (“westward from the pole” 1.1.34) does correspond to the astronomical records (Falk, 2014, p. 148), indicating expert knowledge by the playwright. Thus, it seems possible that there is a connection between Tycho, Elsinore, a new star, and two characters that appear in Hamlet.

Taken together, we find abundant evidence to support the hypothesis of Henry Neville as the Bard, including his specialized knowledge of astronomy and access to the ideas of astronomers at the forefront of the Copernican revolution. However, this evidence is not conclusive. Can we apply a “control experiment” approach by looking for similar lines of evidence available to support the hypothesis that William of Stratford was the Bard? We know nothing about William’s education. It is possible that he could have learned about astronomy, including recent developments, from Leonard Digges, but there is no evidence for this except that Digges’ widow’s new husband was an overseer of his will: Such posthumous evidence does not prove the Stratford man had astronomical knowledge or ever met Leonard. In comparing the weight of evidence concerning the knowledge of astronomy that is evident in the Shakespearean canon, Neville emerges as a much stronger hypothetical candidate than William.

**Foreign affairs, languages, and geography.** The Bard’s plays contain a number of instances that imply privileged knowledge of events overseas. One well-known, although disputed, example is knowledge of the 1609 Bermuda shipwreck, in time to incorporate it (“the still-vex’d Bermudas”) in Act 1, Scene 1, line 228 of The Tempest (Casson & Rubinstein, 2016, p. 219; James & Rubinstein, 2005, p. 196). The first report of this ship wrecked in a storm by a survivor—the Strachey letter (July 1610)—would have been available only to senior investors in the Second London Virginia Company, which included Neville. The letter was received in London in time for it to inspire the first scene of the Tempest which was on stage by late 1610 or 1611. Another example is prior knowledge that Count Orsino would be in London during the Christmas period of the years 1600-1601—in time for the first performances of Twelfth Night (he is named in that play 3 times). Such information would only be available to the few individuals with privileged access to diplomatic communications, such as Neville, who had received the information in a letter from his secretary Ralph Winwood dated 20th November 1600 (Sawyer, 1725, p. 275).

Knowledge of modern foreign languages, including Italian and French, seems a necessary requirement for the Bard to account for the performance of several plays predating translation of their source material into English; an example is The Merchant of Venice. Neville, the diplomat, was proficient in foreign languages, including Italian; he had Italian books in his library including a 1581 De Commentarii della Lingua Italiana, published in Venice by Girolamo Ruscelli; a copy of Francesco Guicciardini’s Della Historia D’Italia dated 1580 and published in Venice; a copy of Velutello’s 1581 edition of Petrarch’s poems (Con L’Esposizione) with many passages underlined (Casson & Rubinstein, 2016, p. 8).

Finally, as mentioned above, Roe (2011) and others have, based on their own expeditions, provided systematic evidence that the Bard knew details of the geography of Northern Italy. Neville traveled through this area during 1581. What do we know of William of Stratford’s knowledge
of these matters? Knowledge of the Bermuda shipwreck and Count Orsino’s appearance at court cannot be easily explained. It is widely assumed, but undocumented, that a friend of William’s, such as John Florio, translated source material for him. As noted above, there is no evidence that William left the country (overseas travel was controlled by the Privy Council). In addition, other authorship candidates who did not visit Italy, such as Francis Bacon and Mary Sidney, become less likely.

Windsor. Another special case concerning detailed knowledge of geography concerns Windsor. The Merry Wives of Windsor has been considered in detail as a test case for authorship (Casson & Rubinstein, 2016, p. 109). Neville’s house at Billington was a dozen miles from Windsor through the forest of which Neville and his father were custodians; the play shows a detailed knowledge of the local geography of Windsor and Berkshire. Neville served as the Member of Parliament for New Windsor and held many Berkshire offices. New research into the play has shown that there are plot devices, word associations, and jokes that all make sense when we posit Neville as the author. We have documentary evidence of his knowledge of Windsor, witch hunting, forestry, horse stealing, German ambassadors, and the Garter ceremony. He even knew the host of the Garter Inn (Casson et al., 2018, p. 113).

Evidence Based on Textual Analysis

References in the plays to France. As an example of evidence of special geographical knowledge and experience, we examine the Bard’s references to France in his plays. Our strategy here is to look at the plays that have scenes in France, count the number of lines, note the dates of the plays, and display the results in a graph (Figure 1). Shakespeare set many scenes in France from the very beginning of his writing.

Thus, Henry VI Part 1 (1589), Edward III (1593), Love’s Labour’s Lost (1594-1595) and King John (1589-1596) all have scenes in France. In most of these early plays, the scenes in France have more lines than those set elsewhere. The dates of these plays might be questioned and adjusted: For example, although King John is dated 1596, it is based on The Troublesome Raigne, which must have been written between 1589 and 1590 (Bradbeer & Casson, 2015, p. 22). This earlier version has scenes in France, so we might see King John as part of the earliest plays set in France. In mid-career, there are also scenes in France in Henry V (1599), As You Like It (1600), and All’s Well That Ends Well (1604). Throughout his career, the Bard referred to France in plays, some of which have French characters or plot lines, suggesting that he was familiar with France.

When we consider Henry Neville as the author, we can see that he had been to France twice, in 1578 and 1582, several years before Shakespeare started writing. He returned to France in 1599 and the scenes set in France in Henry V were written at the time Neville was in France as an ambassador and was writing letters to the French government in French. This accords with the scene in France where princess Catherine is learning English: Only someone who had easy familiarity with the language could write such a scene with its playful, even obscene, use of the French tongue. Indeed, there is documentary evidence that Neville was involved in helping a young Englishman who was sent to him to learn French (Sawyer, 1725, p. 167). Thus, Shakespeare had a bias toward France: the word “France” is used 385 times by the Bard; “French” 166 times. This contrasts with “Italy” 35 times and “Italian” 14 times; “Warwickshire” twice (Henry VI Part 3 and Henry IV Part 1.)

Neville went to France in 1599, presumably hopeful of success, but came home disillusioned and was disgraced. The gap between these references to France is then understandable. His life experience fits: his last time in France being perhaps recalled in the first play to attempt a happy ending after the grim period of imprisonment in the Tower and the bitter tragedies of Troilus and Cressida and Othello. In his case, we might expect there to be no mention of France (and his failed ambassadorial experience) while the disgraced Neville was imprisoned. The very title All’s Well That Ends Well suggests a man emerging from a dark period. In other words, the trajectory of Neville’s life fits these observations concerning France: Not only did he travel to France, but his recent experience in France would explain the triumphant hope of 1599 in Henry V winning in France and the bitter comedy of All’s Well That Ends Well.

In Cymbeline, a Frenchman in the play remembers meeting Posthumus in Orleans (1.4.26). In a letter to Winwood dated March 5, 1601, Neville referred to “mine host of Orleans” (Casson & Rubinstein, 2016, p. 294, footnote). France is mentioned 4 times in the play, although no scene takes place there: Experiences in France are recalled, which makes sense when we posit Neville as the author.

In Double Falsehood, a late play cowritten with John Fletcher based on a segment of Don Quixote, the Duke is anxious about a younger son called Henriquez, which is Spanish for “son of Henry.” In 1609, Neville’s son Henry had been studying in France. He was accused of theft by a French captain, Jean Gandon, and received a serious head injury during a violent arrest. It is little wonder then, that in this first scene of the play, which has been attributed to the Bard, the father should be concerned about a wayward son. This incident would have been in Neville’s consciousness as he wrote a play about a wayward son. In Cervantes’ text, there are no trips to France, but that is where Julio has come from when the play starts.

In Henry VIII, scholars agree that the first scene was written by Shakespeare. In this scene, George Neville appears on stage as Lord Abergavenny with Buckingham, his father-in-law. Norfolk describes the 1520 Field of the Cloth of Gold. Three members of the Neville family attended this glittering
extravaganza, when the kings of France and England met to establish a brief peace treaty: Ralph Neville, 4th Earl of Westmoreland, George Neville, and his younger brother Sir Edward Neville, the last being Neville’s grandfather. We can see then that Shakespeare refers to France in these three late plays in a way that supports Neville’s authorship. A similar approach could be applied to other authorship candidates.

Evidence based on rare word usage. Some experimental tests of each authorship hypothesis are possible by applying modern stylistic methods. For example, if there are adequate samples of pertinent data (such as poems or other writings) from an authorship candidate, then it becomes possible to compare word choice with that in the Shakespeare canon. As noted above, this has been applied to Christopher Marlowe, whose word choice shows significant differences from the Bard (Craig & Kinney, 2009, p. 40; Taylor & Egan, 2017). To date, Neville’s writing has not been tested using this approach measuring the frequency of word choice. One alternative is to focus on rare word usage.

We have compared the numbers of hapax legomena—words that the Bard only used once in his works—with Neville’s extant letters for the period 1599-1600, when he was English Ambassador to France (Sawyer, 1725, pp. 16-304). Scholars have previously used hapax legomena as evidence of authorship, for example, of the Epistles in the New Testament (Harrison, 1921), as well as in the Shakespeare authorship debate (Egan, 2017, p. 30). Such an analysis shows that Neville used rare vocabulary approximately once every 100 words and that he used them either before or contemporaneously with the Bard. Some specific examples follow.

Figure 1. Comparison of percentage of lines of Shakespeare’s plays spoken by characters located in France.
Note. Reference to France, a French character, or French plot may also be present in some plays that do not contain lines spoken by characters in France.
In his letter of August 1, 1599, to Robert Cecil (Sawyer, 1725, p. 82), Neville used the words “inconveniences” and “petit” which were only used once by Shakespeare, in Henry V. Furthermore, Neville used these rare words from the play in similar circumstances: For example, “inconveniences” occurs in a context of international negotiations in France in both the play and Neville’s letter. In his letter Neville also wrote, “such petit respects of Profit.” In the prologue to Act 3 of Henry V there is, “Some petty and unprofitable dukedoms.” The alliteration is actually stronger in Neville’s letter (“petit respects of Profit”). Shakespeare used the word “petit” in Henry V when a French soldier asks, “Petit monsieur, que dit-il?,” the Bard writing in fluent French (4.4.50). In the August 1, 1599, letter we also find other special words that occur in the play such as “articles,” “yoke,” “Roüen,” “preservation,” and “unprovided.”

**Evidence based on hendiadys (word coupling).** Another analytic approach concerns hendiadys: coupling two words together in an explanatory fashion such as in “slings and arrows.” We have conducted a comparison of the frequency of this device and vocabulary used in Hamlet with Neville’s trial deposition of March 1601 (Bradbeer & Casson, 2015, p. 152). His trial deposition contains 1,379 words of which 426 occur in Hamlet: 30.9%—nearly one third of the statement—sharing vocabulary with the play. It contains 16 hendiadyses, 12 of which contain words used in the play. As a control study, we compared Neville’s letters with those of Edward De Vere, the 17th Earl of Oxford, and found that Neville’s use of words from Hamlet is almost double that of Oxford’s in selected contemporary letters (Bradbeer & Casson, 2015, p. 163). Neville’s vocabulary is also richer. There are also far more instances of two Hamlet words occurring together in Neville’s trial deposition than in Oxford’s letters. These preliminary results indicate that further, more rigorous, computer-based studies would be worthwhile in comparing the works of the Bard with the writings of Sir Henry Neville.

**Concluding Comments**

Some orthodox scholars deny that aspects of Shakespeare’s works must reflect the experience of the writer: James Shapiro (2013) advised that, “The sooner that those of us who teach or write about Shakespeare for a living abandon making selective autobiographical connections, the faster the anti-Stratfordian movement will wither” (p. 240). The reason for this injunction is that the Stratford William’s life does not fit what is revealed about the writer in the works. And yet, William from Stratford is almost universally believed to be the Bard. In science, such a dominant paradigm would be questioned, especially if there were evidential anomalies that such orthodoxy could not explain. The Shakespeare Authorship Trust and the Shakespeare Authorship Coalition have highlighted a growing number of anomalies that undermine the Stratfordian orthodoxy. As Ball (2014) wrote, “Attention to anomalies remains a central principle of science—that is, after all, how quantum theory emerged in the early twentieth century, forced upon us by a few niggling problems with what otherwise seemed to be a satisfying and complete scheme of classical physics” (p. 99, footnote). Such anomalies lead to doubt and questioning and a search for new evidence. Those who have been researching the Authorship Question have not only added to the list of anomalies but have turned up further evidence to support the hypothesis that “Shake hyphen spear” was a pseudonym and that someone other than William from Stratford wrote the plays.

Over the last 200 years, a series of candidates have been proposed who can all be seen as hypotheses in response to the question that had emerged from reasonable doubt. Each hypothetical candidate offers evidence that must be considered critically, and we hope to have laid out some principles that might guide such a scientific evaluation, focusing mainly on Henry Neville and William from Stratford. We must fact check and test speculations: Is there evidence that supports such speculation or are we building cloud-capped towers on insubstantial, baseless beliefs that will melt into thin air? Thus, an essential ingredient in the scientific method—and one that has served it well—is skepticism. As physicist Richard Feynman (1998) pointed out, doubt is an essential ingredient of scientific progress, and Michel de Montaigne (2003) reminded us to ask ourselves: “Que sçay—je?”—“What do I know?”

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**Notes**

1. This spelling appears on Stratford-upon-Avon documents (Pointon, 2011, pp. 11-24). His six generally accepted, extant signatures are variations on “Shakespere” (Davis, 2013). In this article, we distinguish between the actor-business man, whom we refer to as “William from Stratford,” and the writer of the plays and poems, whom we refer to as “Shakespeare” or “the Bard.”

2. Probability is a degree of belief, for example, that something will happen. Bayes theorem is concerned with conditional probability: It tells us the probability of some hypothesis being true if new data become available. The condition is the
discovered new data. To test the hypothesis requires estimation of three quantities: (a) The prior probability \(X\) that the hypothesis was correct before the new data were discovered. (b) The probability of the new observation appearing, conditional on the hypothesis being true \(Y\). (c) The probability of the new observation appearing, conditional on the hypothesis being false \(Z\). Knowing these three quantities \(X, Y, Z\), we can calculate the revised (or posterior) probability that the hypothesis is correct:

\[
\text{Posterior probability} = \frac{XY}{XY + Z(1-X)}.
\]

It is possible to apply Bayes theorem to update our estimate that the probability that our hypothesis is true with each new, independent piece of evidence. Thus, the posterior probability that our hypothesis is true after calculating for the first piece of evidence becomes the prior probability as we calculate for the second piece of evidence, and so on. For worked examples and a discussion, see Silver (2012, pp. 240-261).

3. All references to the Shakespearean canon (cited in parentheses) are taken from Taylor and Egan (2017).

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