



The State of Authorship Attribution Studies: Some Problems and Solutions

JOSEPH RUDMAN

Carnegie Mellon, Pittsburgh, Pennsylvania 15213, U.S.A. (e-mail: rudman@cmphys.phys.cmu.edu)

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Abstract. The statement, “*Results of most non-traditional authorship attribution studies are not universally accepted as definitive,*” is explicated. A variety of problems in these studies are listed and discussed: studies governed by expediency; a lack of competent research; flawed statistical techniques; corrupted primary data; lack of expertise in allied fields; a dilettantish approach; inadequate treatment of errors. Various solutions are suggested: construct a correct and complete experimental design; educate the practitioners; study style in its totality; identify and educate the gatekeepers; develop a complete theoretical framework; form an association of practitioners.

1. Introduction

Non-traditional authorship attribution studies – those employing the computer, statistics, and stylistics – have had enough time to pass through any “shake-down” phase and enter one marked by solid, scientific, and steadily progressing studies. But, after over 30 years and 300 publications, they have not.

These studies (experiments) must not only form and force a consensus on methodology among their practitioners but they also must demand an intellectual and a scientific respect for and belief in their results. This is lacking. There is more wrong with authorship attribution studies than there is right.

In this paper I attempt to:

1. Show that serious problems exist in non-traditional attribution studies;
2. Detail a few of the more common or crucial problems;
3. Highlight some solutions.

But most of all I would like to fuel a concerted effort to look at this field in a scientific way – to treat each study as a unique, hard scientific experiment with the concomitant controls, rigor, reproducibility, open availability of all data, programs and tests performed, and with a well articulated theoretical framework.

There are many more problems and solutions than those treated below. There also is a real need to list and discuss what is “right” with non-traditional authorship attribution studies. Many practitioners have done credible work and have advanced

the field. However, this paper concentrates on the majority of studies – studies that evidence major problems.

Nor can the question whether all of the building blocks of non-traditional authorship studies are set on a solid foundation or on quicksand be treated in this paper. An in-depth book length treatment of every facet of the field is forthcoming.

2. Problems Exist

The Bibliographies of stylistics contain thousands of titles, there is no lack of observed facts; however, the polysemy of concepts, the imprecision of methods, the uncertainty about the very goal of this research hardly make for a prosperous discipline.

Todorov¹

The results of most non-traditional authorship attribution studies are not universally accepted as definitive. One major indication that there are problems in any field is when there is no consensus on results, no consensus as to accepted or correct methodology, and no consensus as to accepted or correct techniques. An even stronger indication of problems is disagreement over many of the underlying assumptions – in our case in the “core” fields of statistics and stylistics – assumptions such as the consciousness or unconsciousness of style or the randomness of word selection.

I am not the first to point out this lack of consensus. Others, Ledger,² Brunet,³ and Burrows,⁴ to name just a few, describe aspects of this debilitating fact. But so far with little effect. It seems that for every paper announcing an authorship attribution method that “works” or a variation of one of these methods, there is a counter paper that points out real or imagined crucial shortcomings:

- Even as early as 1903, Robert Moritz pointed out major flaws in the 1888 “Sherman principle” of sentence length as an indicator of style and authorship;⁵
- Mealand called Neumann’s heavy reliance on discriminant analysis “problematic”;⁶
- Donald McNeil pointed out that scientists strongly disagree as to Zipf’s Law;⁷
- Christian Delcourt raised objections against some uses of co-occurrence analysis;⁸
- Portnoy and Peterson pointed out what they considered errors in Radday and Wickmann’s use of the correlation coefficient, chi-squared test, and t-test;⁹
- Hilton and Holmes showed problems in Morton’s QSUM (cusum) technique;¹⁰
- Smith raised many objections against Morton’s early methods;¹¹
- In fact, Morton’s methods have been assailed since 1965 when Ellison said that Morton’s methods were, “. . . an abuse of both computers and scholar-

ship.” “When put to the same tests . . . [Morton’s] own writings seemed to bear the stamp of multiple authorship”;¹²

- There are the lengthy and well documented Merriam versus Smith controversies;¹³
- Foster’s attribution of “A Funeral Elegy” to Shakespeare is under fire;¹⁴
- And there is the current Foster versus Elliott and Valenza brouhaha unfolding on the pages of *Computers and the Humanities*.¹⁵

This widespread disagreement not only threatens to undermine the legitimate studies in the court of public and professional opinion but it also has kept authorship attribution studies out of most United States court proceedings. For example, the judge in the Patty Hearst trial ruled that Dr. Singer’s testimony on stylistic comparisons should not be admitted into evidence.¹⁶ Great Britain’s judicial system, which accepts authorship attribution as a legitimate science, is faced with a serious quandary since one of its star expert witnesses in these cases, Morton, had his method seemingly debunked on live television.¹⁷

The cause of so much disagreement and misunderstanding is not always on the part of the reader. The onus of competency, clarity, and completeness is on the practitioner. The researcher must document and make clear every step of the way. No smoke and mirrors, no hocus-pocus, no “trust me on this.”

There is also a lack of continuity. Many, if not most of the attribution studies are done by a “one problem” practitioner with no long range commitment to the field. This might always be a problem, but understandably so. Once a scholar’s specific attribution study is completed (with or without valid results), why should that scholar continue with other attribution studies in alien fields.

Non-traditional authorship attribution studies bring a unique problem to interdisciplinary studies: who is the authority? who is the experimental spokesman? the group leader? Is it the linguist? the statistician? the computer scientist? the rhetorician? Is it the expert in the field of the questioned work: literature? classics? law? philosophy? religion? economics?

What journal or journals do we turn to for an *imprimatur* or even a *nihil obstat*. A quick scan of my working bibliography shows that non-traditional authorship attribution studies have been published in well over 76 journals representing 11 major fields – not to mention the 50 or so books, 11 dissertations, and numerous conference proceedings.

3. Problems

As the problems are discussed, I am not going to list all of the specific references to the flawed research. Rather, I will list generic problems and give some specific examples. I would like as much as possible to avoid even the appearance of ad hominem attacks and mere polemics.

PROBLEM (1)

Most authorship attribution studies have been governed by expediency, e.g.:

1. The copy text is not the one that should be used but it was available in electronic form and isn't too bad.¹⁸
Neither time constraints nor funding constraints should preclude the correct copy text.
2. This is not how the data should have been treated but the packaged program that I used didn't do exactly what I wanted.
Never let the computer program dictate the design of the experiment. Practitioners should at least understand enough about programming to know what the computer can and cannot do.
3. The control data aren't complete but it would have been too complicated to input the complete set.
4. The control data are not from the correct time period (authors, genre) but they were available in machine readable form.
5. I only had one year to do the research and the study, so some corners had to be cut.

It is important that both readers and practitioners realize that there is nothing, nothing in an authorship attribution study that is beyond the responsibility of the practitioner. If you are planning a study and cannot get the correct electronic texts, or you realize that control texts do not exist, do not do the study. If packaged programs cannot do the needed analysis, either write the program, hire it out, or do not do the study.

PROBLEM (2)

There is a lack of competent and complete bibliographical research and there is little experimental memory. Researchers working in the same subject area of authorship attribution often fail to cite and make use of pertinent previous efforts. Willard McCarty's recent posting on *Humanist*, although in a more general context, points this out:

... scholarship in the field is significantly inhibited, I would argue, by the low degree to which previous work in humanities computing and current work in related fields is known and recognized.¹⁹

How many authorship attribution practitioners are aware of William Benjamin Smith who, under the pen name of Conrad Mascol, published two articles, one in 1887 and the other in 1888 describing his "curve of style."²⁰ This is the same year – 1887 – that Mendenhall published his "Characteristic Curves of Composition."²¹ But Smith is just not mentioned. In 1888, Sherman's "principle of sentence length as an indicator of style and attribution" was published, but Sherman is very rarely mentioned. Mendenhall is usually cited as if in a vacuum.

Kenneth Neumann's impressive 1990 dissertation, *The Authenticity of the Pauline Epistles in the Light of Stylostatistical Analysis*, didn't reference Mascol's two 1888 articles on the "Curves of Pauline and Pseudo-Pauline Style."²²

Most of us are aware of David Holmes' "The Analysis of Literary Style – A Review."²³ It is one of the most referenced works on authorship attribution studies. But, how often has Gerald McMnamin's excellent 1993 book, *Forensic Stylistics*,²⁴ been referenced?

How many studies and articles written in English reference the untranslated works from the French, the German, the Russian, and other languages.

PROBLEM (3)

Professor G.E.P. Box and Dr. F. Yates expressed reservations about the encouragement of unthinking manipulation of numbers. We share their view that statistical methods should not be applied to numbers but rather to the situations giving rise to the data.

Andrews & Hertzberg²⁵

Many researchers are led into this swampy quagmire of authorship attribution studies by the ignis fatuus of a more sophisticated statistical technique. Too many researchers have a great new technique and go looking for a quick and easy problem – one with available data. Simply using statistics does not give validity to attribution studies. Too many papers place too much emphasis on statistical technique – they try to create an aura of scientific invincibility without scientific rigor.

The earlier examples of non-consensus mentioned in *Section 2* are all examples of a disagreement over statistics.

Blind borrowing of statistical techniques from other disciplines must stop:

- The Efron-Thisted tests (expanded from Fisher) are from butterfly collecting;
- Simpson's index is based on the distribution of different species co-existing in a given ecosystem;
- The modal analysis used by Elliott's group is derived from signal processing;
- Morton's QSUM is based on industrial process and quality control monitoring.

The Efron-Thisted tests are based on the assumption that things (words) are well mixed in time. The assumption is that you will not capture all the members of one species early on and all of the members of another species later.²⁶

McNeil, in his work on estimating an author's vocabulary, assumes that vocabulary is fixed and finite and that the author writes by successively drawing words from this collection, independently of the previous collection.²⁷

We must be leery of assumptions. We must be able to prove any assumptions. Statistics should not be the tail that wags the dog of attribution studies.

Where is compliance or even reference to the 1978 “Proposed Criteria for Publishing Statistical Results,” that appeared in the *Bulletin of the Association for Literary and Linguistic Computing*²⁸ or the 1980 “Statement on Statistics,” that was printed in *Computers and the Humanities*?²⁹ Are they still adequate? Should they be updated?

But, statistics should not become the bugaboo of attribution studies. Statistics is a sine qua non.

PROBLEM (4)

As incorrect and inappropriate as some statistics are, it is the primary data that is at the root of many if not most of the problems in authorship attribution studies. It is a given that the primary data or texts being used in attribution studies should be as close to the original holograph as possible – each stage of removal introduces systematic and other errors that may be fatal.

Many studies fail to comprehend that the concept of “author” changes throughout the ages and plays a significant part in setting up each authorship study.

- Oral Tradition
 - Homer. How long after the initial composition were the Iliad and the Odyssey first put in written form? How much of the text is formulaic phrases used as memorization aids?³⁰ How do you account for this in an attribution study?
- Scribal Tradition
 - The scribe in ancient Hebrew literature not only re-wrote but interpreted.
 - Plato. How much of his work comes to us by way of amanuenses? How soon after Plato spoke did they write? What do you do with this text?
- Dramatic Tradition

What do we have when we look at the text of a Shakespeare drama? How many actual words and phrases were copied over from his source material such as Holinshed’s *Chronicles* or North’s *Plutarch*? How many entire passages were paraphrased? How many years elapsed from the date the play was first written until the text we now have was printed? How many directors, actors, copy scribes, pirate publishers, textual scholars, and editors made additions or other changes, intentional or inadvertent? Drama is by its very nature a collaborative genre.³¹ And then we are doing authorship studies on these plays using hapax legomena and rare word tests!

Corrupted texts are another major data problem.

- Authorial Corruption
 - Plagiarism
 - Imitation
 - Lifting from the author’s earlier work
 - Translation
 - Substantial quotations

- Editorial Corruption
 - Typesetting mistakes
 - Changing word forms to comply with a style sheet
 - Supplying missing words to fill damaged text

- Experimental Corruption
 - Re-Pointing
 - Modernizing the spelling
 - Lemmatizing
 - Allomorphs

If you do not have a viable text, why do the study? Garbage in, garbage out. The most important lesson here is that many attribution experiments cannot be successfully completed and should be aborted after a preliminary analysis.

Problem (5)

Too often researchers brush aside the needed expertise in allied fields:

- I am not an expert in linguistics, but . . .
- I am not an expert in statistics, but . . .
- I am not an expert in text authentication, but . . .
- I am not an expert in 18th century literature, but . . .

Anthony Kenny, in his well respected *Aristotelian Ethics*, stated:

To be fully qualified to undertake such a task a man must be a professional philosopher, classicist, and statistician. I can claim to be professionally qualified only as a philosopher: I am a very amateur classicist and a complete novice in statistics. My excuse for being undeterred by this is the fact that most of those working in the field of literary statistics are also, in one or other respect, novices, or, as they would no doubt prefer to put it, pioneers.³²

Leon Gleser stated that statistics, “. . . allows me to enter almost any field, and without a need to get really deep information about the subject matter of that field . . .”³³

Problem (6)

A little Learning is a dang'rous Thing;
 Drink deep, or taste not the Pierian Spring:
 There shallow Draughts intoxicate the Brain,
 And drinking largely sobers us again.

Pope³⁴

The problem of ignorance is rampant – not knowing the pitfalls, not understanding the assumptions, implicit and/or explicit. You must be able to prove any assumptions that you make.

A major commitment to fully research, study, and understand all of the aspects of authorship attribution (traditional and non-traditional) is demanded. The above quote from Pope says it well.

We should understand that style is a complex package consisting of a theoretically unique combination of thousands of individual traits – a very large but finite number. Working with a given attribution problem means that style is a closed system with a finite number of style markers.

Problem (7)

Where is the treatment of errors? How many studies even bother to report on errors? How many studies have corrected an answer for systematic errors? How many studies cite a reference such as Yardly Beers' *Introduction to the Theory of Error*?³⁵

- Systematic (Experimental) Errors
 - Mistyping homonyms
 - Input errors – mechanical and human
 - Editorial intervention
 - Program bugs
- Random (Numerical) Errors
 - Standard deviations
 - Statistical fluctuations
- Illegitimate (Avoidable) Errors

Some errors of this type are not serious enough to invalidate the results, but many are.

 - Cherry Picking
 1. Not holding out a randomly selected sub-set of the author's known writing to be used later as one type of control.

2. Using only tests that prove a pre-conceived theory while discarding those that cause problems with that theory.
 - Blunders

4. Solutions

The following solutions do not mirror or answer the above problems number for number. Many of the problems are dissipated by simply articulating them – the solutions being self evident. And remember, a traditional authorship study looking at all of the external and traditional internal evidence must be completed before a non-traditional study is undertaken. Non-traditional attribution studies provide only a few of the tools for the attribution scholar. And these tools are by no means the most important.

SOLUTION (1)

Have a complete and correct experimental design. Do the study right. This seems simple enough – a truism. But you must know what right is. How many of the researchers who publish have read or are even aware of a significant percentage of the body of literature? My working bibliography contains well over 600 relevant entries.

Every practitioner should be familiar with and follow the research design principles put forth in books like Hatch and Lazaraton's *The Research Manual*³⁶ or Milliken and Johnson's *Analysis of Messy Data*.³⁷

Each study must have a well defined experimental set up – all of the constituent parts are needed for a valid study.

Every concept must be uniquely defined – e.g. what is a word, what is a sentence?

Everyone should read and adhere to the tenets promulgated in the National Academy of Sciences' monograph *On Being A Scientist: Responsible Conduct in Research*.³⁸

SOLUTION (2)

Educate the practitioners. Produce explanatory histories, "how to" handbooks, and complete annotated bibliographies.

More courses and workshops such as The University of Glasgow's "Workshop in Computationally Intensive Methods in Quantitative Linguistics" should be offered. But more comprehensive authorship attribution workshops also should be mounted.

Make sure that the totality of the field is known:

- The various types of authorship attribution studies and what is necessary to competently complete each;

- Anonymous work – no idea of potential author.
 - Anonymous work – two, three, or some other small workable number of potential authors. This is the least complicated one. The one that has the most legitimate studies. You eliminate all but a few potential authors and then say which of the candidates most likely is the author of the questioned work. However, the practitioner should be aware of the potential for error. The possibility of deception should be thoroughly investigated. Mosteller and Wallace's *Federalist Paper* study falls here.³⁹ Foster's *Primary Colors* study falls here.⁴⁰ Holmes' *Cassandra* study falls here.⁴¹
 - Anonymous work – a collaboration.
 - Anonymous work – did Author "A" write it. To call this a simple test of homogeneity as Mosteller and Wallace⁴² did is to seriously understate the problem.
- There are variations of the above. There also are other considerations such as translations and editors – from a commercial editor to a more intimate type. An example of this is the *Frankenstein* work of Mary and Percy Shelley.⁴³

One of the most important facts to keep in mind is that each authorship study is different. Not only are there the various types but each author, each genre, each language, each time period force variations on the experimental design and require a unique expertise. And those 600 references I mentioned earlier do not include references to this kind of expertise – e.g. the working bibliography on my 20 year (but seemingly endless) Defoe attribution studies is well over 1,000 entries.

SOLUTION (3)

Study style in its totality. Approximately 1,000 style markers have already been isolated. We must strive to identify all of the markers that make up "style" – to map style the way biologists are mapping the gene.

Function words, type/tokens, word lengths, hapax legomena, and other specific style markers may not in themselves be an indicator of a unique style, but when used in conjunction with all of the other quantifiable indicators that make up style, they become important.

Many studies have compared a single style marker (or some small number of style markers) to a fingerprint – an authentication method considered infallible. However, one whorl or one loop is not sufficient for a positive identification. Also, there have been no practitioners who have claimed infallibility for their study – although the QSUM proponents come close.

A better analogy would be to DNA matching. The autoradiogram with its multiple markers does not claim infallibility but does claim probabilities approaching certainty.⁴⁴ The same idea behind the DNA scientist's concern with population genetics (correcting for demographics) applies to attribution studies. However, the

attribution scientist must correct for genre, date of publication, language, country, and other like concerns.

It is important to look at as many of the myriad style markers as possible – some markers will overlap with those of the controls and of the other suspects, but a matching pattern should emerge.

Because a style marker or a group of style markers is shown to be effective in one study does not mean that the same marker(s) will be as effective, or even of any value, in another study. Authorship studies must not fall into the trap of discarding style markers from their stylistic autoradiogram because they didn't work in some other study. Until the study is done, it is not known which style markers will be the discriminators.

SOLUTION (4)

Identify and educate the gatekeepers: journal reviewers, conference reviewers, and funding agencies. If you have the expertise, become a gatekeeper. The same education talked about for practitioners should be put in place for the gatekeepers.

We, as a discipline, want to avoid even the appearance of a Sokal syndrome – although the author might not be parodying a legitimate study.

SOLUTION (5)

Develop a complete and necessarily multi-faceted theoretical framework on which to hang all non-traditional authorship attribution studies.

Publish the theories, discuss the theories, and put the theories to experimental tests.

SOLUTION (6)

The field of authorship attribution is large and unwieldy as a discipline. It is time that those working in the field from all the various disciplines come together to discuss and decide how to proceed. Should there be an annual meeting in conjunction with the ACH/ALLC conference? – a listserv? – a web page? Ideally, this would be an ongoing group that would then become the authority.

I would like to invite any and all interested parties to contact me with ideas and suggestions on getting such a group started.

5. Conclusion

I hope that this overview presented enough of what I consider important problematic facets of non-traditional authorship attribution studies to encourage every practitioner to re-think the field and to invest the time and effort to conduct valid

experiments. Because of past problems and the current lack of a unified methodology, future non-traditional attribution studies must be held to a higher standard of competency and completeness.

The worst case scenario is that nothing changes. The practitioners agree that there are problems – but not with their own studies. And then nothing but another spate of flawed articles.

Notes

- ¹ Todorov. "The Place of Style in the Structure of the Text," p. 29.
- ² Ledger. *Re-counting Plato*, p. 1.
- ³ Brunet, "What do Statistics Tell Us?" p. 72.
- ⁴ Burrows, "Numbering the Streaks of the Tulips?" See especially paragraphs 1 and 2.
- ⁵ Moritz. "On the Variation and Functional Relation of Certain Sentence Constants in Standard Literature," e.g. page 242.
- ⁶ Mealand. "The Extent of the Pauline Corpus: A Multivariate Approach," p. 64.
- ⁷ McNeil. "Estimating an Author's Vocabulary," p. 92.
- ⁸ Delcourt. "About the Statistical Analysis of Co-occurrence."
- ⁹ Portnoy and Peterson. "Biblical Texts and Statistical Analysis: Zechariah and Beyond," p. 13.
- ¹⁰ Hilton and Holmes. "An Assessment of Cumulative Sum Charts for Authorship Attribution."
- ¹¹ Smith. "An Investigation of Morton's Method to Distinguish Elizabethan Playwrights."
- ¹² Phillips. *NYT*, 23 Jun 65, p. 17.
- ¹³ Merriam. "Smith on Morton." (See also Dr. Smith's "An Analysis of the Arguments," appended to the Merriam article.)
- ¹⁴ See "Attributing A *Funeral Elegy*."
- ¹⁵ Elliott and Valenza. "And Then There Were None: Winnowing the Shakespeare Claimants." Foster. "Response to Elliot [sic] and Valenza, 'And Then there Were None'."
- ¹⁶ "United States v. Hearst," p. 895.
- ¹⁷ Matthews. "Harsh Words for Verbal Fingerprints."
- ¹⁸ E.g. see Lana. "Xenophon's *Athenaion Politeia*," p. 18.
- ¹⁹ McCarty. "Communication and Memory in Humanities Computing."
- ²⁰ Browne. *Titan vs Taboo*, p. 47.
- Mascol. "Curves of Pauline and of Pseudo-Pauline Style I."
- Mascol. "Curves of Pauline and of Pseudo-Pauline Style II."
- ²¹ Mendenhall. "The Characteristic Curves of Composition."
- ²² Neumann. *The Authenticity of the Pauline Epistles in the Light of Stylostistical Analysis*.
- ²³ Holmes. "The Analysis of Literary Style – A Review."
- ²⁴ McMenamin. *Forensic Stylistics*.
- ²⁵ Andrews and Hertzberg. *DATA*.
- ²⁶ Valenza. "Are the Thisted-Efron Authorship Tests Valid?"
- ²⁷ McNeil. "Estimating an Author's Vocabulary."
- ²⁸ Ross and Brainerd. "Proposed Criteria for Publishing Statistical Results."
- ²⁹ "Statement on Statistics."
- ³⁰ See Foley. *Oral Tradition in Literature*, esp. p. 3.
- ³¹ For a detailed discussion of this see McDonald's *The Bedford Companion to Shakespeare*, especially pages 24 through 28 and chapter 3.
- ³² Kenny. *The Aristotelian Ethics*. Oxford: Clarendon Press, 1978, p. v.
- ³³ Clark, "A Passion for Statistics," p. 20.
- ³⁴ Pope. *An Essay on Criticism*, p. 14.
- ³⁵ Beers. *Introduction to the Theory of Error*.

- ³⁶ Hatch and Lazaraton. *The Research Manual: Design and Statistics for Applied Linguistics*. See also Hatch and Farhady. *Research Design and Statistics for Applied Linguists*.
- ³⁷ Miliken and Johnson. *Analysis of Messy Data (Vol. 1: Designed Experiments)*.
- ³⁸ National Academy of Sciences. *On Being a Scientist: Responsible Conduct in Research*.
- ³⁹ Mosteller and Wallace. *Applied Bayesian and Classical Inference*.
- ⁴⁰ Foster. "Primary Culprit."
- ⁴¹ Matthews. "Unmasking Anonymous."
- ⁴² Mosteller and Wallace. *Applied Bayesian and Classical Inference*, p. 275.
- ⁴³ Robinson. *The Frankenstein Notebooks*. See "MWS and PBS's Collaboration in The Frankenstein Notebooks," pp. lxvi–lxxi.
- ⁴⁴ Kirby. *DNA Fingerprinting*, p. 164.

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