

A New-Dominant Hand: Can Forensic Document Examiners Correctly Associate the Dominant-Hand Writing to the Non-Dominant-Hand Writing of the Same Person?

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Use of the non-dominant hand is a method sometimes employed by those trying to disguise their natural handwriting. However, intentional disguise is not the only reason a person may use his or her non-dominant hand to write. The number of service members and civilians who have lost the use of their dominant hand due to injury and/or illness has risen steadily over the years. For those people, writing with their non-dominant hand is not done as a means of disguise but, rather, as a necessity. What was once their non-dominant hand must now become their new-dominant hand. As their population increases, forensic document examiners (FDEs) are more likely to be faced with a situation in which they must examine and compare writing from a person's dominant hand to the writing from that same person's non-dominant, or new-dominant, hand. In this study, fifteen FDEs performed comparisons between dominant-hand writing and non-dominant-hand writing of both printed and cursive samples. The FDEs were able to identify the dominant and non-dominant-hand writing of the same person with 93.75% accuracy for cursive writing (6.25% error rate) and 87.22% accuracy for handprinting (12.78% error rate). Nine laypeople (LP) performed the same examinations with much lower accuracy rates. Laypeople scored 81.02% accuracy for cursive writing comparisons (18.98% error rate) and 74.07% accuracy for handprinting comparisons (25.93% error rate). This study not only shows that FDEs can identify the non-dominant-hand writing of a person given only that person's dominant-hand writing, but also that they do so with more accuracy than do laypeople.

Introduction

Since 2001, the wars in Iraq and Afghanistan have resulted in at least 1,650 American service members with traumatic limb amputations. [1] The year 2016 was the first in which the United States reported zero amputations to active duty service members deployed in war zones. [2][3] The research presented here originally began in 2011 with a focus on wounded warriors. However, in the United States there are approximately 2,000,000 people [4] currently living with limb loss, and an additional 158,000-185,000 Ameri-

cans undergo amputations every year. [5][6] Considering the current combined numbers of military and civilian amputees in the United States alone, and the fact that the number is expected to double by 2050 [7], this research is probably long past due.

The exact number of people who have lost the use of their dominant hand/arm due to injury or illness is unknown. However, the ratio of upper-extremity amputation to lower-extremity amputation is 1:4. [8] Therefore, it follows that approx-

This research is dedicated to all active-duty service members and veterans of the United States Military.
Thank you for your service.

imately 500,000 of the 2 million US amputees are missing an upper limb.

In addition to amputees, as many as 3 million more people have lost the use of their hand(s), forearm(s), and/or arm(s) due to congenital or injury related impairment or paralysis. [9]

Outside of the military population, the majority of lower extremity amputations are due to illness. [10] However, most upper body amputations are a result of traumatic injuries, such as those caused by motor vehicle accidents, workplace accidents, and power saws. [11] Motor vehicle related amputations more often result in the loss of the left hand/arm [12] while workplace and agricultural related amputations more often result in the loss of the right hand/arm. [13] A significant number of amputations, as well as other types of upper limb traumas, result in the permanent loss of use of the dominant hand. [14] No matter the cause, when a person loses the use of the dominant hand, he or she is forced to perform motor tasks with the non-dominant hand. Between 27-56% of upper-extremity amputees use a prosthetic device. [15] Unfortunately, modern prosthetics cannot provide the fine dexterity that is required for handwriting and therefore, this difficult task is instead most often delegated to the non-dominant hand. [16]

"Hand dominance is the preferential use of one hand over the other for motor tasks." [17] The motor task most closely associated with handedness is handwriting [18] and it is the highest form of single-handed dexterity achieved for most people. [19][20] Estimates vary slightly, but today as much as 90% of the US population is naturally right-hand dominant. In the United States, and many other countries around the world, the prevalence of right-hand dominance has dropped as the acceptance of left-handedness has increased. As recently as fifty years ago, school children in the US were forced to write with their right hand, even if they showed a preference for their left hand. As the stigma that surrounded left-handers has decreased, the number who report left-hand dominance for writing and other fine motor tasks has increased. [21] Numerous theories exist as to the exact cause of handedness, though we do know that hand dominance is determined in-utero. [22] Studies show that fetuses exhibit a preference for one hand over the other and that the in-utero preference strongly correlates to the handedness expressed after birth. [23] There is also a strong inheritance pattern to handedness, suggesting that it may be genetic. McManus reports that handedness may be determined by as

many as 40 different gene loci rather than just one. [24]

Over the years, many words have been used to describe the non-dominant hand including awkward hand, off hand, weak hand, subdominant hand, unaccustomed hand, wrong hand, opposite hand, unpracticed hand, unskilled hand, other hand, and non-preferred hand, to name just a few. Because of the strong prevalence of right-handedness, sometimes the non-dominant hand is simply referred to as the left hand, though this is hardly accurate for natural lefties.

Forensic document examiners (FDEs) have long viewed use of the non-dominant hand to be a means of disguising one's writing to evade detection. In previous studies, Alford reported 6% (8 of 135), Davidson reported 4% (2 of 50), Durina reported 21% (13 of 62), and Harrison reported 5% (1 in 20) of study participants chose to use their non-dominant hand when asked to disguise their writing. [25][26][27][28] But intentional disguise aside, there are other instances in which a person may use his/her non-dominant hand for writing. The temporary or permanent loss of use of the dominant hand due to injury, illness, or amputation *requires* the transfer of dominant-hand skills to the non-dominant hand. In these instances, use of the non-dominant hand is not a matter of choice, but instead a matter of necessity. So although FDEs have long considered writing with the non-dominant hand to be nothing more than a form of disguise, it may be time to alter that thinking and realize that the writing being examined might not have been produced by a non-dominant hand, but rather a *new*-dominant hand.

Numerous studies support that forensic document examiners can accurately identify the author of a questioned writing no matter whether it is written in manuscript print, cursive script, or uppercase printing. [29][30][31] Studies have also shown that FDEs do so with higher accuracy than do laypeople. [32][33][34][35][36][37][38] However, none of these studies have included non-dominant-hand writing or printing. In general, the typical consensus amongst FDEs is that writing from the dominant hand should not, and potentially cannot, be compared to writing from the non-dominant hand. However, Harrison, Huber & Headrick, Stevens, and Kelly all support that examinations can be performed between dominant and non-dominant-hand writings and conclusions can be rendered. [39][40][41][42]

Dawson and Comeau have previously presented results obtained when left-hand writing was 'matched' to right-hand writing. Dawson

had twenty right-handed participants handprint the text of the *London Letter*. Then each participant wrote the same text with his/her left (non-dominant) hand. Dawson himself then correctly matched up the samples written by the right (dominant) and left (non-dominant) hand of each participant with an accuracy rate of 100%. [43] Similarly, Comeau asked forty participants to write a paragraph of text once with his/her right hand and once with his/her left hand. Comeau's participants included six writers who were left-hand dominant and thirty-four writers who were right-hand dominant. Comeau found that eight FDEs were able to correctly match the left-hand dominant writers to their non-dominant writing 80% of the time and the right-hand dominant writers to their non-dominant writing 87% of the time. Both of these studies show that FDEs can not only 'match up' the dominant and non-dominant hand writing of an individual, but that they can do it with a fairly high level of accuracy. [44] Unfortunately, neither of the studies truly represents the casework conducted by FDEs. When performing a 'matching' exercise, once a pairing is made, that sample is effectively removed from the sample population. With each successive pairing, the size of the sample population is further reduced until there are no samples remaining. So with each pairing, the examiner has fewer and fewer choices, and hence, fewer and fewer opportunities to make an error. In real casework, the sample size and the error potential are never reduced. This study was designed to more closely resemble actual casework performed by forensic document examiners.

The purpose of this study is to determine the accuracy rate of forensic document examiners when comparing handwriting samples written with opposite hands. In other words, can FDEs accurately identify the dominant-hand writing of a person given only a sample of writing produced with their non-dominant hand, and vice versa. Comparisons were performed on printed samples and cursive samples and the accuracy rates and error rates were calculated. A group of laypeople (LP) performed the same comparisons performed by the FDEs and their accuracy and error rates were calculated as well.

Methods and Materials

Writing Material

The *London Letter* is a paragraph of text that is frequently used by forensic document examiners

to collect handwriting samples. The paragraph consists of eighty-five words and contains both uppercase and lowercase versions of each letter of the alphabet, numerals 0-9, and some commonly used abbreviations. [45] In this study, the writers were asked to write the *London Letter* once with their dominant hand and once with their non-dominant hand.

Writing Subjects

Writing samples were collected from forty-three people. Twenty participants provided both printed and cursive samples. Eleven participants provided printed samples only. Twelve participants provided cursive samples only. Each writer provided demographic information about age, sex, handedness, and education.

The writers were between fifteen and sixty years old, with the average age being thirty-seven. Ten men and thirty-three women participated. Thirty-seven of the writers were right-hand dominant and six writers were left-hand dominant. One of the writers was still in high school, four of the writers were still in college, but most of the writers had at least a 4-year college degree. The writing group consisted of students, administrative professionals, teachers, and forensic scientists. The writers did not receive any type of compensation for their time.

FDE Participants

A total of fifteen forensic document examiners participated in this study, including eleven from the United States and four from Australia. Four FDEs had ten or fewer years of experience. Eleven FDEs had more than ten years of experience. All FDE participants have been vetted by the American Society of Forensic Document Examiners and/or the Australasian Society of Forensic Document Examiners. The FDE participants did not receive any compensation for their time.

Laypeople Participants

Nine laypeople participated in the study. All LPs were from the United States. They ranged in age from thirty to seventy-three years old, with the average age of fifty. One LP had some college education, four LPs had college degrees, and four LPs had post-graduate degrees. LP participants spent between 1.5 hours and 12 hours on the project, with the average time being 4.4 hours. The LP participants did not receive any compensation for their time.

Comparisons

Thirty-two pairs of cursive writing and thirty-one pairs of printing were collected from the writers. A **pair** is one *London Letter* written with the dominant hand and one *London Letter* written with the non-dominant hand from the same person. The pairs were sorted into groups that showed strong pictorial similarity. Once the pairs were grouped for similarity, they were arranged into thirty-two mock cases. Each 'case' contained one questioned document (Q) and three known specimens (K). Each K was written by a different writer. Cases 1-16 contained handprinted Qs and Ks and cases 17-32 contained cursively written Qs and Ks. Cases 1-8 and 17-24 contained Qs written with the non-dominant hand and Ks written by the dominant hand. Cases 9-16 and 25-32 contained Qs written with the dominant hand and Ks written by the non-dominant hand. **The purpose of this study is to determine if writing from a person's dominant hand can correctly be 'matched' to writing from his/her non-dominant hand, therefore all cases were comparisons between dominant-hand writing and non-dominant-hand writing.** (Images of "Case 1" can be found in APPENDIX A. Notice the pictorial similarity between the known specimens K1a, K1b, and K1c.)

Each participant was provided with a DVD containing the study information and documents as well as images of the cases for comparison. Participants were given both pdf and 600ppi TIFF images for their comparisons and they were able to decide for themselves to do the comparisons by viewing the images on a computer screen or by printing the images onto paper.

The FDE participants and the LP participants were asked to examine each case and determine which, if any, of the known specimen writers was the writer of the questioned document. (The instructions that were provided to the FDEs and LPs are included in APPENDIX B. Contact information of the author has been redacted.) The participants were required to select from one of eight defined conclusions in determining authorship or non-authorship. These conclusions were based on terminology widely-accepted in the profession of forensic document examination. (APPENDIX C shows the nine levels of confidence used to express conclusions which was provided to the LP participants). These conclusions are based on "Standard Terminology for Expressing Conclusions of Forensic Document Examiners"

published by SWGDOC.) [46] For this exercise, neither the FDEs nor the LPs were allowed to provide an opinion of "no conclusion". The participants recorded their conclusions on the answer sheet which was then submitted via mail or email.

Results

FDE Accuracy and Error Rates

The total number of conclusions rendered by FDEs, including those for cursive writing and handprinting, was 1440 (32 cases x 3 conclusions per case x 15 FDEs). Of the 1440 conclusions rendered, 1303 conclusions (90.49%) were correct and 137 conclusions (9.51%) were incorrect. A correct call required that the writer of the known sample was either correctly identified or correctly eliminated as the writer of the questioned writing. (A 'correct identification' included conclusions of identification as well as the qualified conclusions of highly probable did write, probably did write, and indications did write. A 'correct elimination' included conclusions of elimination, as well as the qualified conclusions of highly probable did NOT write, probably did NOT write, and indications did NOT write.)

FDEs were more accurate in their conclusions reported on cursive writing than on handprinting. The accuracy rate for cursive comparisons was 93.75%, with 675 correct calls out of 720 calls made. The error rate for cursive comparisons was 6.25%, with 45 incorrect calls of 720 calls made. The accuracy rate for printing comparisons was 87.22%, with 628 correct calls out of 720 calls made. The error rate for printing comparisons was 12.78%, with 92 incorrect calls out of 720 calls made. Table 1 shows the accuracy and error rates for the FDEs.

Table 1. Accuracy and Error Rates for FDEs.

FDE	Calls Made	Accuracy Count	Accuracy %	Error Count	Error %
Cursive	720	675	93.75%	45	6.25%
Handprinting	720	628	87.22%	92	12.78%
Total	1440	1303	90.49%	137	9.51%

Laypeople Accuracy and Error Rates

The total number of conclusions rendered by LPs, including those for cursive writing and

printing, was 864 (32 cases x 3 conclusions per case x 9 LPs). Of the 864 conclusions rendered, 670 conclusions (77.55%) were correct and 194 conclusions (22.45%) were incorrect. A 'correct identification' and a 'correct elimination' were determined in the same manner as stated previously.

Like FDEs, the LPs made fewer errors when comparing cursive writing than when comparing handprinting. The accuracy rate for cursive comparisons was 81.02%, with 350 correct calls out of 432 calls made. The error rate for cursive comparisons was 18.98%, with 82 incorrect calls out of 432 calls made. The accuracy rate for printing comparisons was 74.07%, with 320 correct calls out of 432 calls made. The error rate for printing comparisons was 25.93%, with 112 incorrect calls out of 432 calls made. Table 2 shows the accuracy and error rates for the Laypeople.

Table 2. Accuracy and Error Rates for Laypeople.

LAYPEOPLE	Calls Made	Accuracy Count	Accuracy %	Error Count	Error %
Cursive	432	350	81.02%	82	18.98%
Handprinting	432	320	74.07%	112	25.93%
Total	864	670	77.55%	194	22.45%

Accuracy and Error Rates of FDEs versus LPs

FDEs were more accurate than LPs when determining authorship and non-authorship for both cursive and printed samples. FDEs were accurate 93.75% of the time when examining cursive samples compared to an accuracy rate of 81.02% for LPs. For printed samples, FDEs were accurate in their conclusions 87.22% of the time compared to 74.07% for the LPs. The accuracy rate for FDEs for all samples, cursive and printing combined, was 90.49% versus 77.55% for the LPs. See Table 3 and Figure 1.

FDEs made far fewer errors than LPs for both cursive and printing examinations. When examining cursive writing samples, LPs made errors 18.98% of the time, however FDEs made errors only 6.25% of the time. Laypeople erred 25.93% of the time on printed sample examinations compared to a 12.78% error rate for FDEs. The total error rate for cursive and printed samples combined was 22.45% for LPs and 9.51% for FDEs. See Table 4 and Figure 2.

Table 3. Comparison of Accuracy Rates for FDEs and Laypeople.

Accuracy %	
FDE Cursive	93.75%
LAYPEOPLE Cursive	81.02%
FDE Handprinting	87.22%
LAYPEOPLE Printing	74.07%
FDE Combined	90.49%
LAYPEOPLE Combined	77.55%

Table 4. Comparison of Error Rates for FDEs and Laypeople.

Error %	
FDE Cursive	6.25%
LAYPEOPLE Cursive	18.98%
FDE Handprinting	12.78%
LAYPEOPLE Printing	25.93%
FDE Combined	9.51%
LAYPEOPLE Combined	22.45%

The probability that FDEs and LPs are equally proficient at determining authorship for samples from a writer's dominant and non-dominant hand was found to be less than 0.0001 overall (ChiSq=41.30; $p < 0.0001$), less than 0.00001 for cursive writing (ChiSq=44.62; $p < 0.00001$), and less than 0.00001 for handprinting (ChiSq=32.03; $p < 0.00001$). The raw scores used to calculate probability can be found in Table 5 and Table 6.

Discussion

This study reinforces that forensic document examiners perform significantly better than laypeople in both cursive and printing comparisons. It also reinforces higher accuracy rates for cursive writing comparisons than for handprinting comparisons. Most importantly, this research provides evidence that FDEs can correctly associate or disassociate both cursive writing and printing from the dominant and non-dominant hand of the same person with a significantly higher degree of accuracy than can laypeople. Even though the questioned and known samples were written with different hands, FDEs were still able to ex-

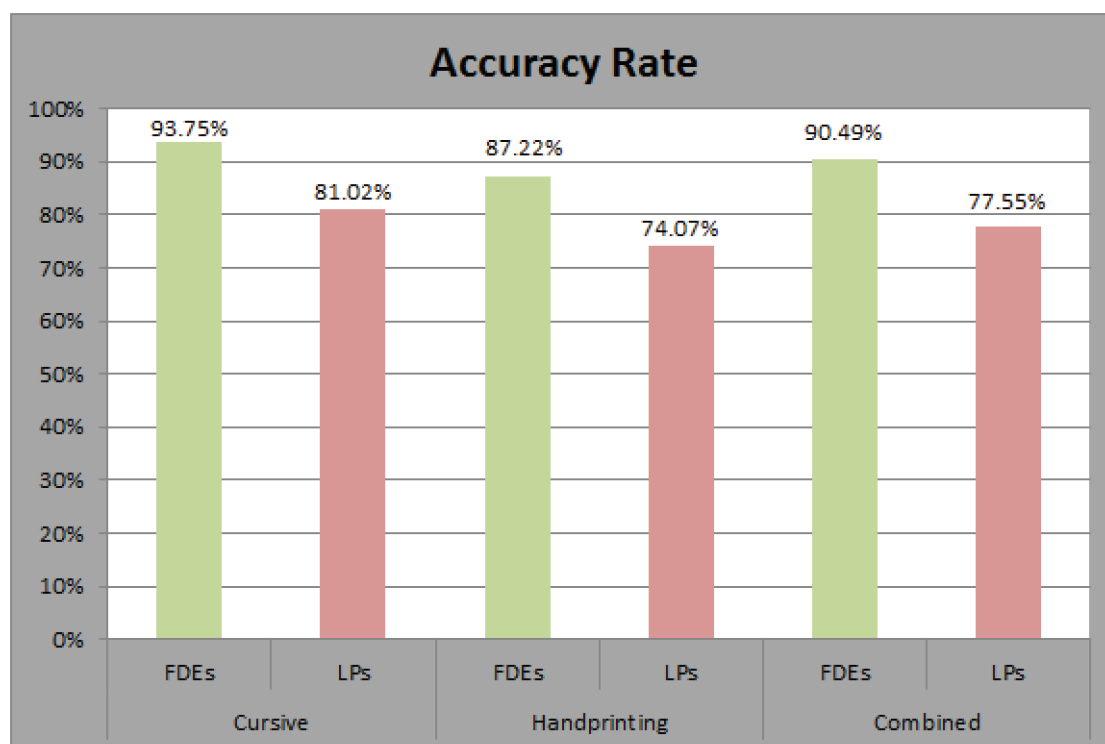


Figure 1. Comparison of Accuracy Rates for FDEs and Laypeople.

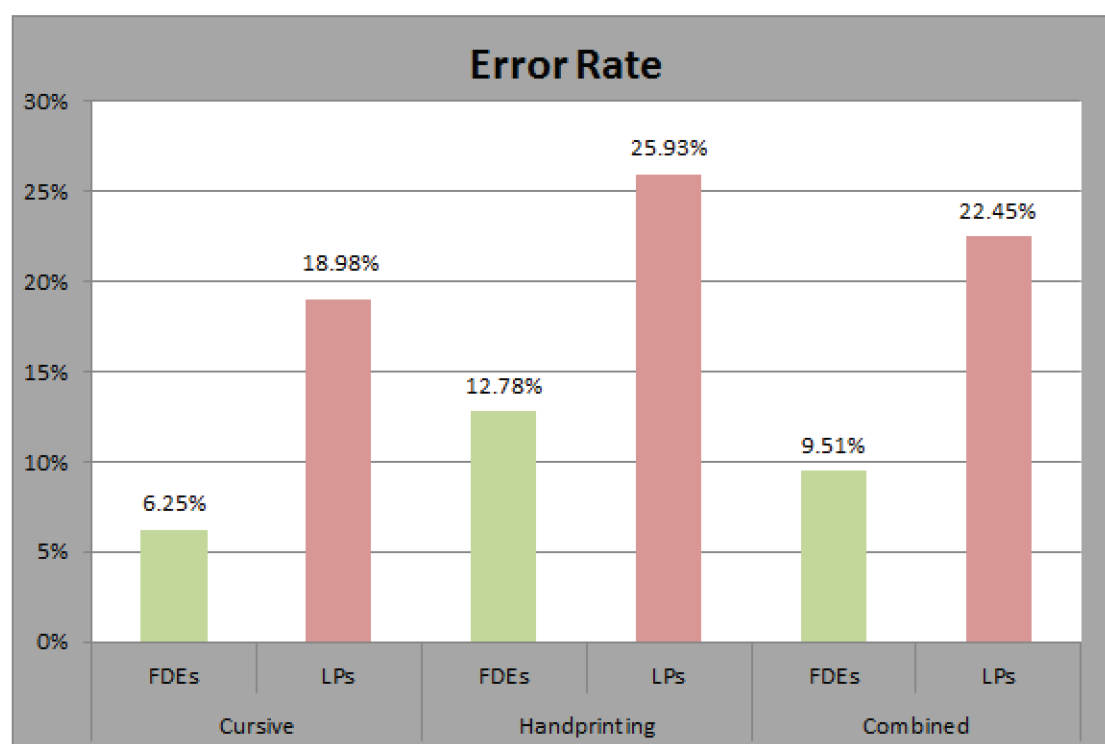


Figure 2. Comparison of Error Rates for FDEs and Laypeople.

Table 5. Raw Scores for FDEs.

FDE Raw Scores						
FDE #	Totals		Cursive Comparisons		Printing Comparisons	
	Score out of 96	% Correct	Score out of 48	% Correct	Score out of 48	% Correct
001	84	87.50%	43	89.58%	41	85.42%
002	89	92.71%	47	97.92%	42	87.50%
003	94	97.92%	48	100.00%	46	95.83%
004	91	94.79%	45	93.75%	46	95.83%
005	92	95.83%	47	97.92%	45	93.75%
006	92	95.83%	48	100.00%	44	91.67%
007	85	88.54%	46	95.83%	39	81.25%
008	85	88.54%	42	87.50%	43	89.58%
009	80	83.33%	43	89.58%	37	77.08%
010	82	85.42%	43	89.58%	39	81.25%
011	73	76.04%	37	77.08%	36	75.00%
012	89	92.71%	45	93.75%	44	91.67%
013	91	94.79%	47	97.92%	44	91.67%
014	84	87.50%	47	97.92%	37	77.08%
015	92	95.83%	47	97.92%	45	93.75%

Table 6. Raw Scores for LPs.

Laypeople Raw Scores						
Layperson #	Totals		Cursive Comparisons		Printing Comparisons	
	Score out of 96	% Correct	Score out of 48	% Correct	Score out of 48	% Correct
001	81	84.38%	001	43	001	38
002	59	61.46%	002	31	002	28
003	64	66.67%	003	31	003	33
004	62	64.58%	004	34	004	28
005	79	82.29%	005	44	005	35
006	91	94.79%	006	46	006	45
007	73	76.04%	007	37	007	36
008	77	80.21%	008	39	008	38
009	84	87.50%	009	45	009	39

tract enough individualizing features to make accurate determinations about authorship. When there is any possibility that a questioned document was written with the non-dominant hand, it is still important to obtain known specimens from a person's right *and* left hand whenever possible. However, the accuracy rates calculated here should help to relieve some of a foren-

sic document examiner's reluctance to perform handwriting comparisons of this type.

The 'Problem' of Being Conservative

In casework and in testing situations, FDEs tend to be more conservative than laypeople. Kam found that laypeople tend to "grossly over-associate"

and reported that they erroneously “matched” almost six times as often as FDEs (38.3% for laypeople vs. 6.5% for FDEs). [47] FDEs have the opposite problem in that they often under-associate writers. For this study, the instructions given to FDEs and LPs advised them that, as is true in real casework, the true writer of the questioned document might not always be present in the known specimens. However, they were not told how many, if any, did not have matches. In truth, for four of the thirty-two cases (Case 8, Case 12, Case 20, and Case 30) the true writer of the Q was not included amongst the Ks.

Of the 194 total errors made by LPs, only nine (or 4.6%) were due to under-association (over-elimination). Interestingly, five of those nine errors are attribute to Layperson 006 who herself made only five errors total. In other words, all of her errors were due to under-association. Interestingly, Layperson 006 is the roommate and best friend of an FDE, knows quite a bit about forensic document examination, has spoken to her roommate about handwriting examination on numerous occasions, has observed her roommate performing comparisons, and in retrospect should have been removed from the study. However, in the interest of transparency, her scores were retained and reported.

In contrast to LPs, of the 137 errors made by FDEs, eighty-five (or 62%) were due to under-association (over-elimination). In eighteen of the thirty-two cases, FDE 009 marked *all* conclusions on the side of elimination, which resulted in fourteen errors. FDE 010 marked *all* conclusions on the side of elimination for sixteen of the thirty-two cases, resulting in twelve errors. And FDE 011 marked *all* conclusions on the side of elimination in twenty-three of the thirty-two cases, which resulted in nineteen errors.

When faced with non-dominant-hand writing in a casework situation, many FDEs will render an inconclusive opinion and/or will request that additional known specimen writing be submitted. For this study, the participants were specifically forbidden from rendering an opinion of ‘inconclusive’ and were forced to reach a conclusion on the writing samples provided. This type of ‘forced-call’ study is unlike real casework where an examiner can render an opinion of ‘inconclusive’ if the evidence is lacking in some way. In order to gauge how often inconclusive opinions might have been rendered when comparing dominant to non-dominant hand writings, the an-

swer sheet provided a mechanism for doing this. Boxes placed next to each ‘forced-call’ opinion allowed participants the option of recording those instances where, in real case work, they would have rendered an opinion of ‘inconclusive’. The results were intriguing. Of 864 calls made by LPs, only forty-two (4.9%) of the boxes were marked for ‘inconclusive’. However, of the 1440 calls made by FDEs, 514 (35.7%) of the boxes were marked for ‘inconclusive’. The dramatic difference in the desire to render an inconclusive opinion is additional evidence of the conservative nature of trained FDEs and shows their reluctance to over-associate writing samples.

Study Limitations

This study, like all studies, had certain limitations. The comparisons were done using digital images of writing. Though the images were high quality 600 ppi TIFF images, it is always better to examine original documents. The time commitment required for the examinations turned out to be excessive. With the advantage of hindsight, the number of comparisons required of each participant should have been more limited and will be reduced by at least half for the follow-up study. Though it cannot be said for certain, the configuration of the answer sheet was likely a cause of some errors. For the follow-up study, the answer sheet will be adjusted for more distinction between identification and elimination answers. Finally, this study did not allow for “inconclusive” conclusions and in that way was unlike real casework.

Demographic information about years of experience and country of residence was obtained from the FDEs who participated. However, the sample size of fifteen examiners is too small to calculate whether or not the accuracy/error rate was significantly different for either of these two factors.

Future Studies

The comparisons performed in this study were between samples of natural writing from subjects’ dominant hand and from their unpracticed non-dominant hand. The ultimate purpose of this New-Dominant-Hand research is to determine whether or not FDEs can accurately identify the new-dominant-hand writing of a person who has

lost the use of his/her dominant hand/arm due to injury, illness, or amputation. In that case, the writers will have been practicing with their non-dominant (new-dominant) hand and their writing will have theoretically improved from its unpracticed condition. The follow-up study to this one will be comparisons of writing from subjects who have been practicing writing with their non-dominant hand for six weeks. It is expected that FDE accuracy rates will be higher and the error rates lower than those reported here.

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APPENDIX A

Q1

Our London business is good, but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland and I hope for good news. He will be there for a week at 1496 Zermott St. and then goes to Turin and Rome and will join Col. Parry and arrive at Athens, Greece, Nov. 27th or Dec. 2nd. Letters there should be addressed: King James Blvd. 3580. We expect Chas. E. Fuller Tuesday. Dr. L. McQuaid and Robt. Unger, Esq. left on the "Y.X." Express tonight.

K1a

Our London business is good, but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland and I hope for good news. He will be there for a week at 1496 Zermott St. and then goes to Turin and Rome and will join Col. Parry and arrive at Athens, Greece, Nov. 27th or Dec. 2nd. Letters there should be addressed: King James Blvd. 3580. We expect Chas. E. Fuller Tuesday. Dr. L. McQuaid and Robt. Unger, Esq. left on the "Y.X." Express tonight.

K1b

Our London business is good, but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland and I hope for good news. He will be there for a week at 1496 Zermott St. and then goes to Turin and Rome and will join Col. Parry and arrive at Athens, Greece, Nov. 27th or Dec. 2nd. Letters there should be addressed: King James Blvd. 3580. We expect Chas. E. Fuller Tuesday. Dr. L. McQuaid and Robt. Unger, Esq. left on the "Y.X." Express tonight.

K1c

Our London business is good, but Vienna and Berlin are quiet. Mr. D. Lloyd has gone to Switzerland and I hope for good news. He will be there for a week at 1496 Zermott St. and then goes to Turin and Rome and will join Col. Parry and arrive at Athens, Greece, Nov. 27th or Dec. 2nd. Letters there should be addressed: King James Blvd. 3580. We expect Chas. E. Fuller Tuesday. Dr. L. McQuaid and Robt. Unger, Esq. left on the "Y.X." Express tonight.

(The correct match to Q1 is K1b.)

APPENDIX B

A New-Dominant Hand

Instructions

There are a total of thirty-two (32) “cases” to be examined. Cases 1-16 are handprinting and cases 17-32 are handwriting (cursive). Furthermore, some of the Qs (Q means questioned document) (Cases 1-8 and 17-24) are written with the non-dominant hand and are to be compared to three Ks (K means known document) which were written with the dominant hand. An equal amount of Qs (Cases 9-16 and 25-32) are written with the dominant hand and are to be compared to three Ks written with the non-dominant-hand. You may complete the case examinations in any order you wish as long as they are properly scored on the answer sheet.

Each “case” is set up to mimic casework as closely as possible. Each “case” contains one questioned document and three known specimens. For example, Case 1 contains Q1, K1a, K1b, and K1c. Each K is written by a *different writer*. You will need to form *and* record a conclusion for each known writer. As is true with real casework, the writer of the Q *may not always* be represented by the known specimens.

Hints:

1. You may or may not be able to match a K with a Q in each case packet.
2. Because each packet contains Ks written by three *different* writers, no more than one K can be matched with the Q in each packet. (Each Q was written by one writer; therefore you cannot match 2 writers to one Q.)

Your answers will be recorded using a multi-level conclusion scale. I have included an explanation of the “9-Point Conclusion Scale” on the CD. Please familiarize yourself with the conclusions prior to beginning your examinations. “No Conclusion/Inconclusive” is not an option on the conclusion scale for this project. This is for the sole purpose of statistical significance. However, the answer sheet bears a column for each “case” where you can mark that your ‘real world’ answer would have been inconclusive. But you **MUST, MUST, MUST** also make a selection from the 8 available conclusions. If you do not make a selection, your answer will be marked as incorrect.

Additional comments and what you should know:

- Each writer supplied ONE sample from his/her dominant hand and ONE sample from his/her non-dominant hand. Each sample was collected with a black ballpoint pen.
- Assume that the full range of variation is represented.
- Assume that there is no attempt to disguise (aside from use of the opposite hand).
- Nothing has been done to purposely confuse you, trick you, or increase/decrease errors.
- Peer review is permitted, but not required.

If you have any questions about the study or how to complete the answer sheet, please feel free to contact me at [redacted].

Let's begin:

1. Print out the answer sheet on which to mark your conclusions.
2. Open the folder labeled **Cases for Examination**.
3. If you like to work in numerical order, open the folder labeled **HandPRINTING (Cases 1-16)**. If you're a rebel, you can begin with the HandWRITING folder.
4. Inside each folder is a pdf document as well as 600dpi TIF image files. You may find it difficult, or too time consuming to open the TIF files because of their size. You have the option of doing the comparison using the pdf document OR the TIF image files OR both. Both the pdf document and the TIF images depict the Q and Ks (Ka, Kb, and Kc) for that case. The number designator for each Q and K corresponds to the case folder number to help you keep track as you fill out the answer

sheet (i.e. folder 1 contains Q1, K1a, K1b, and K1c).

5. Examine the Q and each of the three Ks in every case file and form a conclusion.

6. Mark your conclusion on the answer sheet. For example:

You MUST mark a conclusion for EACH K specimen!									
Case	Specimen	CONCLUSIONS							"Inconclusive" Mark this box if your "real world" answer would be inconclusive. You MUST also mark a conclusion on the conclusion scale at left.
		Identification	Highly Probable Did Write	Probably Did Write	Indications Did Write	Indications Did NOT Write	Probably Did NOT Write	Highly Probable Did NOT Write	
Q	Ka		X						☐
	Kb					X			☒
	Kc						X		☐

You must mark a conclusion for each K specimen. Be very careful to put your mark in the correct box. After you have selected your conclusion, you can place a check mark in the "inconclusive" box next to that K if you feel that would be the most appropriate 'real life' conclusion. **If you only mark the "inconclusive" box and leave the conclusion scale unanswered, you will be marked incorrect.**

7. After completing the examinations, please return the answer sheet and participant survey to me. You can either scan and email it to me at [redacted] or you can mail it to me at the following address: [redacted]

APPENDIX C

9-Point Conclusion Scale

Identification	The evidence present in the comparable portions of the questioned and known documents supports that the writer of the known document is the writer of the questioned document. This is a definitive conclusion of authorship with the highest degree of certainty.
Highly Probable Did Write	It is highly probable that the writer of the known document wrote the questioned document. An opinion of "highly probable wrote" is a qualified opinion that means that there is very strong evidence in the comparable portions of the questioned and known documents to support common authorship is highly likely. This opinion falls within the "virtually certain" degree of confidence.
Probably Did Write	There is strong evidence present in the comparable portions of the questioned and known documents to support that the writer of the known document probably wrote the questioned document. An opinion of "probably did write" means that there is strong evidence to support that common authorship is more likely than not. This opinion falls short of the "virtually certain" degree of confidence.
Indications Did Write	There are very few features present in the comparable portions of the questioned and the known documents, but the evidence that is present <i>suggests</i> that the writer of the known document wrote the questioned material. An opinion of "indications did write" means that the evidence present <i>suggests</i> common authorship. This opinion is far from conclusive.
No Conclusion	The writer of the known specimen has neither been identified nor eliminated as the writer of the questioned document. This is an inconclusive result because the material present in the questioned and known documents does not allow for a meaningful analysis and comparison. It is unreasonable and not appropriate to assign a conclusion of authorship or non-authorship given the evidence submitted. Therefore, no conclusion as to authorship can be provided.
Indications Did Not Write	There are very few features present in the comparable portions of the questioned and the known documents, but the evidence that is present <i>suggests</i> that the writer of the known document did not write the questioned material. An opinion of "indications did not write" means that there are very few features, but the evidence that is present <i>suggests</i> an absence of common authorship. This opinion is far from conclusive.
Highly Probable Did Not Write	There is strong evidence present in the comparable portions of the questioned and known documents to support that the writer of the known document probably did not write the questioned document. An opinion of "probably did not write" means that there is strong evidence to support that common authorship is unlikely. This opinion falls short of the "virtually certain" degree of confidence.
Probably Did Not Write	It is highly probable that the writer of the known document did not write the questioned document. An opinion of "highly probable did not write" is a qualified opinion that means that there is very strong evidence in the comparable portions of the questioned and known documents to support common authorship is highly unlikely. This opinion falls within the "virtually certain" degree of confidence.
Elimination	The evidence present in the comparable portions of the questioned and known documents supports that the writer of the known document is <i>not</i> the writer of the questioned document. This is a definitive conclusion of non-authorship with the highest degree of certainty.

