GUARDING DOCUMENTS BY INCREASING RISKS AND REDUCING CRIMINAL OPPORTUNITIES: APPLYNG ENVIRONMENTAL CRIME THEORIES TO FORGERY CRIMES

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ABSTRACT

GUARDING DOCUMENTS BY INCREASING RISKS AND REDUCING CRIMINAL OPPORTUNITIES: APPLYNG ENVIRONMENTAL CRIME THEORIES TO FORGERY CRIMES

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Signature forgery is a prominent crime problem that is rarely discussed by criminologists. Additionally, according to the National Research Council of the National Academies of Sciences (2009), it is an area of forensic science that is in need of more rigorous research. The present study has two parts. In the first part, the number and types of changes that typically result when a writer disguises his or her signature were investigated. In the second part, the effect that the level of guardianship has on the interaction between the offender and the guardian in forgery and document fraud crimes was examined. Environmental crime theories suggest that the presence of a guardian reduces crime because it decreases the opportunity to offend (Felson & Clarke, 1998). However, in certain kinds of crimes, the presence of a guardian may not be enough to deter an offender from engaging in criminal behavior; the guardian must also be perceived by the offender as capable and skilled. In the case of forgery crimes and document fraud, it is unclear how offenders respond to and determine capable guardianship. By understanding how offenders interpret and adapt to different levels of guardianship, effective prevention strategies may be developed.

A secondary data source was used for this study. The data were collected from a sample of college students at Michigan State University. Three primary statistical techniques were used for the data analysis portion of the project: (1) Chi-square test of independence, (2) Tukey-Kramer Pairwise Comparisons, and (3) Exploratory Factor Analysis (EFA). The results for the

first part of the study showed that letter form, legibility, size, spelling, and spacing were the most frequently altered handwriting features, and the second part showed that the participants were influenced by the scenario (i.e., level of guardianship).

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ACFE	Association of Certified Fraud Examiners
ASCLD	American Society of Crime Laboratory Directors
CCTV	Closed Circuit Television
EFA	Exploratory Factor Analysis
FBI	Federal Bureau of Investigation
FTC	Federal Trade Commission
GAO	Government Accountability Office
ISMG	Information Security Media Group
MSU	Michigan State University
MSU FCU	Michigan State University Federal Credit Union
NCVS	National Crime Victimization Survey
NIBRS	National Incident-Based Reporting System
NRC/NAS	National Research Council of the National Academies of Sciences
UCR	Uniform Crime Reports

CHAPTER 1: INTRODUCTION

Despite being a common and prominent crime problem with serious financial costs to society, forgery[1] is rarely discussed by criminologists. In fact, of the limited studies that have been conducted on this crime, the most useful ones are only found in the forensic science literature, and they lack research on the human element (i.e., the forgers and the victims). Since these studies have focused primarily on the technical aspects of forgery, they are of little use to criminologists. As a result, the aim in this study was to bridge the gap between criminologists and forensic scientists by advancing the knowledge on the effect that the human element has on the technical aspects of a forgery, and how this information can be useful in preventing this crime or identifying the offenders. The offender-guardian interaction in forgery crimes was examined by looking at the forgery choices that offenders made when they were forced to interact with a guardian[2] in order to carry out their crime. Furthermore, there was a focus on a type of forgery referred to as an auto-forgery[3] (disguised signature), which is commonly used by

[1] A forgery can be defined as the fake making or altering of handwritten or electronically produced documents, artwork, or cultural artifacts with the intent to deceive or defraud (Fenoff, 2013). In this study, the term forgery referred to a non-genuine signature that fell into one of following categories: (1) simple, (2) simulated, (3) tracing, (4) cut-and-paste, or (5) auto-forgery.

[2] In general, a guardian can be identified as a person who watches over a crime target and may intervene or prevent a crime from happening (Felson & Boba, 2010). In this study, guardianship was about scrutiny. In other words, how closely a manager-guardian examined an individual's signature at the transaction point. More specifically, at a restaurant, retailer, and bank setting.

[3] The term auto-forgery is a controversial term used to describe a signature that has been deliberately altered by the author to later deny its authenticity (ASTM, 2007; Harrison, Burkes, & Seiger, 2009; Levinson, 2001; Scientific Working Group for Forensic Document Examination, 2013). In their book on handwriting identification, Huber and Headrick (1999) argued that auto-forgery is a contradiction of terms because while it defines a forgery of one's signature created by oneself, by definition a forgery is created by another person. Nonetheless, auto-forgery is the conventional term used to describe an intentionally disguised signature, and it was used throughout this paper. It was beyond the scope of this study to clarify the auto-forgery concept.

people who want to obtain goods and/or services without paying for them. The rationale for this focus was advancing the understanding of a rarely studied kind of forgery, by identifying the handwriting features that were intentionally and unintentionally altered by the forger.

The four specific goals of this study were as follows. The first goal was to understand the thought process of individuals as they devised a strategy to disguise their signature (created an auto-forgery) under different conditions and circumstances. This knowledge would be valuable to forensic document examiners and investigators who encountered cases involving disguised handwriting, as it will provide them with additional information about the factors that forgers take into consideration when disguising a signature. The second goal was to identify the primary (intended handwriting changes) and secondary (unintended handwriting changes)[4] disguise techniques used by individuals who disguised their signature in order to later deny signing a document. This information will enable investigators to recognize the primary and secondary changes that typically result from employing a particular disguise strategy. Furthermore, one of the weaknesses identified by the National Research Council of the National Academies of Sciences (NRC/NAS) in their 2009 report titled *Strengthening Forensic Science in the United States: A Path Forward,* was addressed. The report highlighted the need to increase scientific knowledge in the forensic sciences through "better" and more rigorous research (NRC/NAS, 2009).

The third goal was to enhance criminal justice and criminology scholars' understanding of manager-guardianship[5], particularly in crimes of forgery and document fraud. This knowledge will provide insight into the offenders' (forgers) perception of the guardians' ability to detect

[4] See Appendix G for a list of the handwriting variables used in this study.

[5] A manager-guardian looks after a place, securing it from crime (Felson, 2006). In this study the manager-guardians were waiters, waitresses, cashiers, and bank tellers.

their disguise strategy, and how they adjusted their behavior accordingly. The fourth goal was to examine the value of marrying social science (e.g., environmental criminology theories) with forensic science (e.g., forensic document examination) to study a specific crime problem, and develop a crime prevention strategy that incorporates both a traditional crime prevention component and a behavior alteration element targeted specifically towards the undeterred offender. Considering the persistent and growing threat of check and card fraud on society, the implications for understanding the offender-guardian relationship in these types of crimes were profound. Knowing how offenders perceive and are affected by the guardian will enable criminal justice and criminology scholars to devise potentially simple and cost effective measures that prevent these crimes, or alter the behavior of those who remain undeterred in such a way that forensic document examiners and investigators can successfully evaluate the signature(s) in question and determine authenticity.

The Problem

The available information on the financial costs of fraud is limited and not very helpful in understanding the scope and scale of specific types of fraud. Unfortunately, official sources of crime data such as the National Incident-Based Reporting System (NIBRS), the Justice Department's Bureau of Justice Statistics National Crime Victimization Survey (NCVS), and the FBI's Uniform Crime Reports (UCR) are not helpful in identifying the number and the different types of forgery crimes that occur each year. For instance, even though the UCR contains arrest data on forgery crimes (Barnett, 2000; Federal Bureau of Investigation, 2014), it does not identify the prevalence and type of forgery committed. Also, while the NIBRS captures more offense types than the UCR and has the ability to collect more specific incident characteristics (i.e., location type, property description, offender information, and type of victim), its

information is limited to known criminal incidents and the specific types of forgery crimes are not well defined and are largely unknown. As for the NCVS, it collects information on property crimes like the UCR and the NIBRS, but it does not collect or report on the number and types of forgery crimes. In summary, official sources of crime data cannot be used to understand the scope and scale of forgery crimes.

The costs associated with financial fraud, and their impact on businesses and the greater economy have been investigated by several organizations over the past few years. In 2003, Klynveld Peat Marwick Goerdeler, a company that provides worldwide audit, tax, and advising services, released the results of its telephone-based fraud survey in which 459 executives from private, public, and government organizations took part. Klynveld Peat Marwick Goerdeler (2004) found that 75 percent of the organizations that participated had experienced an instance of fraud in the past 12 months, representing a 13 percent increase from their 1998 fraud survey. Furthermore, when compared to earlier studies, the different types of fraud occurrences reported almost doubled. For example, check fraud increased from 26 to 40 percent, credit card fraud from 13 to 20 percent, expense account abuse from 13 to 36 percent, and payroll fraud from 3 to 12 percent. For those companies surveyed, the total estimated losses resulting from fraud were more than $296 million annually.

Identifying fraud risks and implementing effective preventive and deterrent measures are paramount steps to mitigate financial fraud. The Information Security Media Group (ISMG), a media company that focuses on information security, risk management, fraud, and compliance, released the results of its 2014 fraud survey in which more than 300 banks, credit unions, and non-banking financial institutions participated. ISMG found that 78 percent of the respondents reported that financial losses from fraud had either increased or remained steady over the

previous year, and that the most common types of fraud experienced by the surveyed organizations were credit/debit card fraud (65 percent), phishing (46 percent), check fraud (43 percent), Automated Clearing House/wire (26 percent), and third-party Point Of Sale skimming (19 percent). The surveyed organizations indicated that their two biggest challenges in preventing fraud was lack of customer awareness (50 percent) and insufficient resources (42 percent). Although 73 percent of respondents rated themselves at average or below average in developing and providing customer awareness programs, only 20 percent of them planned to increase customer awareness programs, and 29 percent planned to invest more fraud prevention resources into fraud detection and monitoring systems in 2015 (ISMG, 2014).

Financial fraud crimes have become more prevalent in recent years and they keep growing as technological advancements continue to flourish. For instance, with bills being conveniently paid online and goods and services being easily purchased with the swipe of a debit or credit card, the amount of debit/credit card fraud has rapidly increased. In this regard, in 2011, the Federal Reserve Bank of Boston's Payment Strategies Group conducted a study on payments-related fraud experienced by financial institutions in the Federal Reserve First District. A total of 70 financial institutions in New England responded to the survey. Of all the different types of payment methods, the signature debit card was reported by 93 percent of the financial institutions as the type that had the most exposure to fraud. PIN debit card and check fraud attempts were the next highest categories at 49 percent. While the percentage of check fraud attempts reported by banks was 67, thrifts and credit unions only reported 33 percent (Federal Reserve Bank of Boston, 2012). Other authors have reported similar findings. For example, the Federal Reserve Bank of Minneapolis identified signature debit cards as the biggest problem, with 79 percent of the financial institutions reporting this type of fraud, followed by checks at 43

percent and credit cards at 18 percent (Federal Reserve Bank of Minneapolis, 2012). Likewise, the Federal Reserve Bank of Dallas reported signature debit cards as the main type of fraud experienced by financial institutions (72 percent), followed by checks (51 percent), and credit cards (19 percent) (Federal Reserve Bank of Dallas, 2012).

Also pervasive in society is occupational fraud. As defined by the Association of Certified Fraud Examiners (ACFE), occupational fraud refers to the use of one's occupation for personal enrichment through the deliberate misuse or application of the employing organization's resources or assets (ACFE, 2014). In 2014, the ACFE released its latest report to the Nations on Occupational Fraud and Abuse, which considered 1,483 cases of fraud reported by certified fraud examiners. The survey participants estimated that a typical organization loses five percent of its annual revenue to fraud. When this was applied to the US estimated gross domestic product, which was $16.8 trillion in 2013 (World Bank, 2014), the losses translated into about $840 billion annually. The ACFE also found asset misappropriation to be the most common form of fraud, encompassing 85 percent of cases; the government, banking and financial services, public administration, and the manufacturing sector to be the most common victims of occupational fraud; and small businesses to be disproportionately victimized by this kind of fraud (ACFE, 2014).

Along with businesses and organizations, individuals are also victims of the current fraud epidemic. In 2009, the Deputy Assistant Attorney General for the Department of Justice's Criminal Division branded identity theft as one of the fastest growing crimes in the US (Department of Justice, 2010). This was supported by the Federal Trade Commission's (FTC) claim that more than 9 million people have their identity stolen each year, with financial identity theft specifically being the most common (White, 2012). Today, identity theft is the most

common form of fraud reported to the FTC (2014a). It has been estimated that over 900 million records containing individuals' identifying information have been compromised by data breaches since 2005, and the monetary losses from these breaches can reach hundreds of millions of dollars (Privacy Rights Clearinghouse, 2014). However, the National White Collar Crime Center warned that it is difficult to estimate or predict the number of compromised records that will be, or may already have been, used fraudulently (National White Collar Crime Center, 2008). The sensitive nature of the information contained in these stolen records, especially social security and credit card numbers, makes consumers vulnerable to identity theft (Guy, 2014), which has been the top consumer complaint for thirteen years in a row (FTC, 2014a). Furthermore, credit card fraud was the second most common form of identity theft reported to the FTC in 2012 (FTC, 2014b).

The trend toward an increased use of debit and credit cards was further illuminated by a retail point-of-sale study conducted by Javelin Strategy & Research in 2012. Data were collected through an online survey of 3,210 randomly selected US consumers. The authors found that although purchases with cash were numerous, these generally had a lower transaction value. While cash was only used 27 percent of the time for higher value point-of-sale transactions, debit and credit cards were used 60 percent of the time. The authors argued that if the use of debit and credit cards becomes more prevalent by 2017, the overall number of cash sales, no matter the transaction value, will decrease (Javelin Strategy & Research, 2012).

Although some forms of financial fraud, such as phishing schemes, telemarketing fraud, and computer related crimes increase in number over time (IC3, 2013; Liesik, 2010; National Consumers League, 2010), no other kind of financial fraud has been as persistent and successful as the crime of forgery, which can be traced back to Roman law under the Code of Justinian in

539 AD (Baker, 1955). According to Baker (1955), forgery was a lucrative business during the Middle Ages, especially for people holding high office positions in Rome and throughout Europe. In fact, the author claimed that forgery was practiced in every country where handwriting was a medium of communication. Currently, most financial frauds and cases of identity theft include a forged or altered document of some sort (FTC, 2014b). With the rapid advancements in computer and printer technology, the creation of counterfeit and forged documents has increased and become an easier and more profitable criminal occupation than in the past (Agar, 2011; Sparacello, 2012).

Although forged[6] and altered documents such as tax returns, wills, deeds, and trusts can have a considerable and immediate impact on the families and individuals involved, forged checks have received the most public attention as far as questioned documents are concerned (Foster, 2012; Tuohy, 2013). In this regard, the United States Secret Service estimated that in 2007 check fraud in the US amounted to more than $5 billion annually (Shreiner, 2013). In fact, the chief of the Secret Service Financial Crimes Division claimed that check fraud was the number one way criminals attacked the nation's financial system (National Check Fraud Center, 2013). Furthermore, the National White Collar Crime Center (2009) claimed that 500 million checks are forged annually in the U.S., equating to about $10 billion in losses. The Federal Bureau of Investigation's Financial Institution Fraud and Failure Report for the fiscal years 2006 and 2007 indicated that the number of suspicious activity reports (SARs) for check related fraud accounted for 27 percent of the 3,186,213 SARs filed by US financial institutions, resulting in

[6] In addition to the different types of forged documents discussed in this section, there are many other kinds of documents that are commonly forged including: social security applications, immigration applications, driver's license applications, tax returns, and property conveyance documents (deeds), among others. Wherever documents are relied upon for identification, the potential for forgery to happen is enormous. Unfortunately, the lack of available data makes it impossible to quantify the true cost of this crime in all of these document areas.

more than $21.4 billion in losses (Federal Bureau of Investigation, 2008). Furthermore, the United States Department of the Treasury Financial Crimes Enforcement Network's *SAR Activity Review, By the Numbers* showed that 27 percent of the SARs filed by depository institutions in 2009 could be attributed to fraud-related activities, and that check fraud was one of only two categories that had experienced an increase in SAR reports between 1996 and 2009 (Financial Crimes Enforcement Network, 2010). A survey completed by the Association of Financial Professionals indicated that 60 percent of corporate member organizations experienced either actual or attempted payment fraud in 2013 (Association of Financial Professionals, 2014). From those, 82 percent were victims of check fraud, followed by credit/debit card fraud at 43 percent (Association of Financial Professionals, 2014). Moreover, the American Bankers Association found that 37 percent of banks reported losses due to check fraud to be an estimated $648 million, and 54 percent of banks reported industry losses from credit/debit card fraud (e.g., point-of-sale signature and pin number) to be an estimated $943 million in 2012 (American Bankers Association, 2013).

The National Check Fraud Center claimed that checks were the payment method most frequently targeted by criminals to commit payment fraud, and that 80 percent of business-to-business transactions were made by check (National Check Fraud Center, 2013). Although the American Bankers Association predicted that the number of checks used in business transactions will decrease slightly in the coming years, it warned that the number of fraudulent checks may actually increase.

CHAPTER 2: CURRENT PROBLEMS THAT THE STUDY ADDRESSED

The Value of Combining Environmental Crime Theories[7] and Forensic Science

While most of the information available on forgery and document fraud came from surveys conducted on businesses or information reported to government agencies such as the FBI, the United States Secret Service, and the FTC, these studies and reports did not provide any details regarding the conditions under which check and card fraud take place. As a result, most of the knowledge about these crimes was deduced from the limited information that was available. For example, the studies completed by the Federal Reserve Banks clearly show that check and card fraud involving signatures has been, and continues to be, one of the financial sectors' biggest problems. This suggested that most check and card fraud involves altered and forged signatures. Although this deduction was helpful, it did not explain how these signatures were produced and under which circumstances the documents were signed.

Although disguised handwriting is regularly encountered in the field of forensic document examination, distinguishing disguise from different authorship remains a problem area for many investigators (Bird, Found, & Rogers, 2010; Bird, Found, & Rogers, 2012), which in part may be due to a serious lack of empirical work on this subject area. The findings of the current study helped fill in the gap in the criminological literature, more specifically in the environmental crime literature, in regards to crimes of forgery and document fraud by exploring the offender-guardian interaction, the offender's perception of the guardian's ability to detect signature fraud, and the kind of disguise strategy employed by the offender based on this

[7] Environmental criminology (also referred to as crime science), is the study of crime places and events (Brantingham & Brantingham, 1991). The term "environmental" is often confused with crimes related to wildlife and environmental harm such as poaching, illegal logging, or pollution. However, the terms that criminologists often use to describe this area of study is conservation (Gibbs, Gore, McGarrell, & Rivers III, 2010) or green (Lynch & Stretesky, 2003) criminology.

capability assessment. Ultimately, this deeper understanding will assist researchers in designing additional research studies and developing practical crime prevention measures.

Although the research described here could have been conducted using environmental crime theories or forensic science independently, it was by combining these two that the crimes of forgery and document fraud could be truly understood in a holistic manner. Traditionally, criminology has focused on offenders and the circumstances that prompt individuals to break the law. Theories of criminal disposition, which have dominated the field of criminology, are based on the principle that people commit crimes for reasons that are generally outside of their control (e.g., disorganized social environment, family dysfunction, poverty, inequality, peer pressure, lack of self-control, genetics, etc.). In contrast, environmental criminologists argue that crime and specific crime events should be examined, not the criminal tendencies of individuals (Clarke, 1980). In this regard, the field of environmental criminology has emerged as an alternative approach to understand crime by focusing on criminal opportunity and the places of crime events. Clarke (1995), along with other environmental criminologists, argued that because crime will persist rather than be eliminated from society, prevention is the best approach. However, since some crimes will persist regardless of the kind of prevention program that is employed, albeit at a lower level, additional information should be collected to understand the undeterred offender (i.e., his behavior and attitudes). As a result, the impact that incorporating behavior alteration strategies into crime prevention programs would have on increasing the likelihood of an offender being caught after committing a crime was explored. According to the FBI's 2012 UCR, a vast majority of offenders get away with their crimes, thus the need to improve the current crime prevention strategies is enormous. The clearance rates for violent and property crimes were 46.8 percent and 19 percent, respectively (FBI, 2013). These statistics suggested

that non-violent offenders' chance of getting away with their crimes is 81 percent, compared to 53 percent of violent offenders. Unfortunately, these low clearance rates are not new. In fact, they have been relatively consistent for the last 18 years (FBI, 2014). Moreover, according to the U.S. Justice Department's Bureau of Justice Statistics, only 36 percent of non-violent crimes were reported to the police in 2013 (Truman & Langton, 2014).

There is no question that crime prevention programs work (National Institute of Justice, 2014; Sherman et al., 1998). However, the numerous published studies that demonstrated their success in deterring some crimes fail to explain why some offenders remain undeterred and often get away with the crime (FBI, 2012). This is where the union of social science (i.e., environmental crime theories) with the technical aspects of forensic science (e.g., forensic document analysis, fingerprint analysis, firearm and tool mark analysis, footmark analysis, DNA analysis, etc.) could be used to understand crime events in a more meaningful way. Social scientists do not know much about the kind of evidence a forensic scientist or investigator needs to solve a crime, nor should they be expected to know. However, social scientists can collaborate with forensic scientists to better understand what kind of evidence is necessary to investigate and solve specific kinds of crime and develop crime prevention strategies that (1) deter potential offenders and (2) manipulate the physical environment so that the undeterred offenders leave behind some useful form of physical evidence (forensic evidence) that would increase their chances of being identified after committing a crime.

Challenges in solving forgery and document fraud crimes

Due to the prevalence of check and card fraud, and the overall pervasiveness of forgery and document fraud throughout society, it is expected that local law enforcement is receiving complaints about these crimes. However, to effectively help the victims, law enforcement

personnel must be knowledgeable about forgery detection and document fraud. Since the training received by police officers is predominantly geared towards the use of force and criminal law enforcement (Walker & Katz, 2005), one can assume that their understanding of forgery detection is limited (U.S. GAO, 2003; U.S. GAO, 2008). Therefore, when they receive a report from a victim of fraud, whether it is a private citizen or a business, police agencies may have to turn to their crime laboratories for assistance in investigating and solving the crime.

Although more than 18,760 police agencies are estimated to exist in the United States (O'Conner, 2011), there are only 392 accredited crime laboratories (ASCLD, 2014), and multiple state crime laboratories do not even have a questioned document section, such as Montana, Tennessee, Vermont, and Wyoming (ASCLD, 2014; Brady, 2007). Considering the limited number of questioned document examination laboratories and the prevalence of forgery and document fraud, local law enforcement agencies are under extreme pressure to either move cases through the system or direct victims to seek redress in court through civil action (NBC News, 2013; New York Post, 2010; O'Farrell, 2013). When law enforcement agencies decide to move forward with an investigation without the assistance of a crime laboratory or a forensic document examiner, it is possible that they may be wasting valuable resources by chasing non-existent offenders or using biased information, due to their lack of training and eagerness to close the case (Miller, 1984; Miller, 1987; Rossmo, 2013). When police officers assume that the person claiming to be the victim of a forgery or document fraud crime is indeed a victim, their investigation focuses on finding the offender. However, in many cases of forgery and document fraud, the crime was actually committed by the complainant (Huber & Headrick, 1999). These "pretend-victims" disguise their signature so that, at a later date, they can deny signing the document. By failing to consider the victim as the suspect, investigators will not identify the

actual signer of the signature in question, and if they do suspect the victim, they will most likely have difficulty providing evidence that supports their suspicion. Without any meaningful training in forgery detection, conducting a simple side-by-side comparison of the signatures is usually not very helpful because the differences between the known and questioned signatures will necessarily result from the intentional disguise strategy used by the offender (Ellen, 2006). Consequently, the investigators may attribute the observed differences to different authorship, when in fact the differences may be the product of disguise. If the investigators recognize that they are unable to identify the author of the signature in question, they may inform the complainant that they cannot solve the crime due to lack of evidence, or they may assist the complainant in clearing his/her name of any wrongdoing by writing a police report that indicates that she or he was the victim of identity theft or check fraud. However, if the complainant is actually the offender, this report becomes his/her get-out-of-jail free card since it essentially prevents the holder from being pursued for that crime. In the absence of punishment, offenders are empowered to continue targeting businesses and individuals, while the real victims are left absorbing the loss or spending more money trying to pursue the matter through civil action. When a business is victimized, rather than seeking monetary compensation through court action, the business owner will generally opt for raising prices and passing the loss to the consumer, who then becomes a victim of the crime as well (Finklea, 2012; Whitt, 2008).

As briefly mentioned above, the generalist nature of police work puts police officers at a disadvantage when it comes to investigating and solving crimes that require specialized skills and training. While experts in questioned documents and forgery detection complete a 2-year training program and many have a college degree (ASTM, 2012), most law enforcement personnel do not pursue a formal 2-year training program and many are not required to have a 4-

year college degree[8] (Luzer, 2010; U.S. Department of Labor, 2012). Therefore, when law enforcement agencies are faced with a crime they have no expertise in, and the state, county, or federal crime laboratories are unable to assist them, they must opt for one of the following options: 1) do their best at investigating and solving the case on their own, 2) contact a forensic document examiner in private practice to assist them, or 3) advise the victim to pursue the case through civil action.

Forensic Document Examiners and Disguised Handwriting

While the prevalence and economic impact of disguised signatures is unknown, its potential impact on society can be gauged by looking at a closely related crime problem: chargeback fraud or "friendly fraud." This kind of crime occurs when consumers use their credit card to pay for a product or service, and then request a chargeback from their bank claiming that they did not make the purchase, when in fact they did (Brown, 2014). In 2012, Mindwave Research released the findings of their Online Fraud Report, which surveyed U.S. and Canadian online merchants to assess online payment fraud trends. The merchants participating in the study reported a total fraud loss of $83 billion in 2011, with chargeback fraud accounting for 41 percent of their losses (Cybersource, 2012). The 2013 LexisNexis True Cost of Fraud Study reported that merchants pay $2.79 in costs for each dollar of fraud losses (LexisNexis, 2013). Although chargeback fraud sometimes does not include a signature, the thought process and scheme (getting something for nothing) is similar to the one used by individuals who disguise

[8] A 4-year degree from an accredited college or university and a 2-year apprenticeship style training program is required to become certified in forensic document examination. Many law enforcement officers do not have a 4-year college degree, and many law enforcement agencies do not have the resources to support an extensive 2-year training program. Therefore, it is difficult for law enforcement officers to become certified in forensic document examination.

their signature in a document so they can later deny signing it. However, unlike chargeback fraud, in cases of disguised handwriting the offender always leaves physical evidence behind. Unfortunately, the quantity and quality of this evidence often varies, and in many cases may not be useful for identification purposes.

Dwindling resources and lack of training in forgery detection prevent most law enforcement agencies from adequately investigating forgery and document fraud crimes, leaving victims defenseless (COPS, 2011; Hamari, 2010; Howard, 2005; New York Post, 2010). Moreover, in cases of disguised handwriting where the complainant can be the actual offender, it seems likely the police are generally unprepared to respond. As a result, law enforcement professionals often seek the assistance of an expert in handwriting identification to assist in forgery cases. When evaluating documents in which the writing is suspected to have been disguised, the forensic document examiner is trained to look for certain handwriting features that are commonly found when an individual attempts to disguise his/her writing in order to avoid being identified. In the literature of forensic document examination, there are two kinds of sources that guide the examiner when evaluating a questioned writing for disguise: books and journal articles. As for books, in many of the ones written on this topic (Conway, 1959; Ellen, 2006; Harrison, 1958; Hilton, 1982; Huber & Headrick, 1999; Osborn, 1929; Robertson, 1991), the authors relied on their personal experience or the experience of others to identify the handwriting features that were commonly found when a writer employed a disguise strategy. In addition, there were empirical studies that investigated disguised writing, many of which focused on anonymous letters and notes (Alford, 1970; Harris, 1953; Keckler, 1997; Konstantinidis, 1987; Leung, Chung, Tsui, & Cheung, 1988; Regent, 1977; Seaman-Kelly, 1999; Tsui, 1997; Willard, 1988), rather than disguised signatures. The few studies that investigated disguised

signatures had small sample sizes and did not consider how intentional changes may have impacted other aspects of the writing (Herkt, 1986; Michel, 1978; Mohammed, 1993; O'Block, 1991).

Although the disguise strategy used to write an anonymous letter and sign a document may seem similar, they can be quite different. In the case of disguised writing for anonymous letters (e.g., bomb threat), individuals are trying to avoid being identified and are not concerned about getting the writing past a guardian. For example, the author of an anonymous letter is not concerned about getting his disguised handwriting past a bank teller or retail cashier; he just wants to conceal his identity. As a result, he will alter his handwriting as much as possible and choose a technique that allows him to maintain his concentration long enough to maintain the disguise without reverting back to his normal handwriting habits (Ellen, 2006; Huber & Headrick, 1999). As for disguised signatures, the individual may or may not be concerned about getting his signature past a guardian. If he is not, he can change his signature in such a way that it looks nothing like his regular one. For instance, the individual may scribble illegible loops and lines that do not resemble his original signature in any way. However, if the individual is worried about getting his signature past a guardian, he can alter his signature in a way that it maintains some pictorial similarity[9] to his normal signature, but is dissimilar enough that at a later point in time he can claim that the signature is not his. If the latter happens, it can become a serious challenge for the forensic document examiner to interpret the similarities and differences found between the questioned and normal signatures. For example, a forensic document examiner may interpret a strategically planned disguise, such as a change in letter-form or a change in the legibility of the signature, as a notable difference and wrongly conclude that the normal and

[9] Pictorial similarity refers to the handwriting features that give a body of writing a certain "look," such as letter form, slant, spacing, and size.

disguised signatures are not of common authorship. Furthermore, the forensic document examiner may wrongly interpret that a difference is the result of disguise when it could actually be the result of different authorship. In fact, various research conducted by scientists at the Forensic Expertise Profiling Laboratory at La Trobe University in Victoria, Australia has indicated that many forensic document examiners have difficulty identifying disguised handwriting (Bird, Found, Ballantyne, & Rogers, 2010; Bird et al., 2012; Dyer, Found, & Rogers, 2008; Found & Rogers, 2008). Therefore, it should not come as a surprise that law enforcement agencies, which are not skilled in forgery detection unlike forensic document examiners, are ill equipped to identify disguised handwriting.

Protecting the Victims by Keeping the Investigators Involved

In many cases of forgery and document fraud, it is unlikely that the investigator will be able to identify the forger (Huber & Headrick, 1999; Osborn, 1929). This is especially true in cases where the differences between a known and a questioned handwriting sample are grotesque (i.e., the signature looks nothing like the original one). In these cases, the forensic document examiner, or investigator, cannot completely identify or eliminate the complainant as the author of the questioned signature. Therefore, if the complainant is truly a victim, he or she will receive no compensation, and if the complainant is the offender (i.e., disguised signature), he or she will receive no punishment. However, in cases where the differences between a known and a questioned signature are minor, some sort of case closure is likely. In other words, a person disguising his signature by simply changing one or two handwriting features will more likely be identified as the author of the signature in question and subsequently punished by being made to pay for the goods and services received, or worse, being prosecuted for the fraud. Considering this, it would be advantageous to create an environment in which the forger believes it is

necessary to avoid deviating too far from the normal signature because he knows the recipient (guardian) will compare the signature with an identifying signature on a driver's license or another document. By making the forger believe that the recipient will be taking a closer look at the signature, the forger may change his behavior. For example, instead of creating a signature that looks nothing like his normal one (e.g., an X mark or a straight line), the forger may only employ a few deviations from his normal signature, such as changes to the capital letters. As a result, when the forensic document examiner or investigator is asked to evaluate the questioned signature, he will have little difficulty in determining its authenticity.

CHAPTER 3: THEORETICAL FRAMEWORK

The theoretical focus of the current study was on the guardianship component of routine activity theory and the role that guardians play in preventing forgery crimes. This theoretical framework was developed from environmental crime theories.

Environmental Crime Theories

Grounded in opportunity theories, environmental criminology is a term used to describe a group of theories about crime events (Cullen & Agnew, 2006). In contrast to traditional crime theories, which focus on the offenders and the circumstances that prompt them to break the law (i.e., theories of criminal disposition), environmental criminologists argue that crimes and specific crime events should also be examined. Since the offender is only one element of a crime, by studying all the aspects of a specific crime event, researchers and practitioners can be in a better position to create crime prevention strategies that reduce opportunities for crime.

A considerable amount of theoretical developments have taken place over the last 30 years in the field of criminology. In environmental criminology, these developments have been used to explain crime events and guide practitioners in the creation and implementation of crime prevention programs (Clarke, 1992; Knutsson, 2006; Sherman, Farrington, Welsh, & MacKenzie, 2002). Three theoretical perspectives that have been developed to understand crime events are: routine activity theory, rational choice, and situational crime prevention. When combined, these perspectives capture the thought process of offenders: how they make the decision of when and where to commit a crime, what makes a suitable target, and how guardians can protect targets (Eck & Weisburd, 1995; Felson & Boba, 2010). Below is a brief description of each perspective.

Routine Activity Theory

While exploring the relationship between humans and their environment, Cohen and Felson (1979) developed the routine activity approach to explain the changes in crime rates over time. They claimed that the increase of crime rates could be attributed to the societal and technological changes that took place after World War II. Cohen and Felson (1979) argued that by recognizing individuals' routine activity patterns, crime could be understood. According to the routine activity theory, three factors must be present for a crime to occur: a motivated offender, a suitable target, and the absence of a capable guardian. The probability of these three elements coming together in space and time is influenced by routine activity patterns such as work, travel, and recreation (Cohen & Felson, 1979). Therefore, structural changes in these patterns can impact crime rates by increasing crime opportunities (Felson, 1987).

Since its origin in 1979, the routine activity approach experienced several major developments[10]. The most remarkable of these was the expansion of the elements needed for a crime to occur: place, controllers, and super controllers (Sampson, Eck, & Dunham, 2010). In this regard, place managers have been added to regulate behavior in the places they control (Eck & Weisburd, 1995), and while the guardian exercises control over the target or victim, an intimate handler has been added to exert some control over a motivated offender (Felson, 1986; Tiller & Eck, 2011). This expansion of the routine activity theory has not only increased the understanding of crime events, but it has provided additional potential points of intervention for other crime problems (Bossler & Holt, 2009; Hollis, Fejes, Fenoff, & Wilson, 2014; Hollis & Wilson, 2014; Madensen & Eck, 2008; Pires & Clarke, 2012; Reyns, 2013; Tillyer & Eck, 2011; Warchol, 2011).

[10] For example, Danielle Reynald elaborated on the concept of guardianship and provided a new means of measuring it by directly observing human behavior (Reynald, 2009; Reynald, 2010; Reynald, 2011a; b; c).

Rational Choice

While routine activity theory identifies the necessary elements for a crime to occur, the rational choice perspective describes how offenders make decisions (Tillyer & Eck, 2011). Based primarily on economic theories of crime, the rational choice perspective asserts that crimes are the result of rational choices made using a benefit-cost analysis; an offender will commit a crime if the expected utility exceeds the expected costs (Cornish & Clarke, 1987; Jacobs, 2010). Consequently, deciding to participate in crime is a two-part process. First, individuals must be willing to commit a crime (the involvement decision), and then they must decide what crime they want to commit (the event decision), which is strongly influenced by the immediate situation (Cornish & Clarke, 1986; Kroneberg, Heintz, & Mehlkop, 2010). For instance, after making the decision to perpetrate a robbery, the offender determines when, where, and how the robbery will be carried out. Considering the bounded rationality of individuals' decision-making (Garcia-Retamero & Dhami, 2009; Jacobs & Wright, 2010), the rational choice perspective acknowledges that the information an individual uses to make a decision may be inaccurate or impaired by situational changes, such as drug and alcohol use or moving to an unfamiliar location (e.g., new neighborhood, different facility, etc.). Nonetheless, the offender's decision-making ability evolves over time since it is shaped by experience. Through experience, offenders learn which discriminative cues are associated with good targets, and they use these positive cues to make decisions about future crime events (Jacobs, 2010). Although the positive reinforcement obtained from previous crime events can lead to an increased frequency of offending (Tillyer & Eck, 2011), Cornish and Clarke (1986) pointed out that an offender may also choose to stop committing crimes if more attractive alternatives to crime are available. Furthermore, the authors argued that the decision to discontinue criminal activity may be influenced by a negative

experience during a criminal event or by a change in the offender's personal circumstances. Supporters of rational choice theory argue that crime prevention strategies should focus on eliminating crime opportunities and/or shifting the perceived benefits and costs, rather than focusing on the criminal tendencies of individuals.

Situational Crime Prevention

Situational crime prevention aims to reduce crime opportunities through the manipulation of the immediate environment. It is grounded in the rational choice perspective, but it draws from the routine activity theory to deal with specific forms of crime (Tillyer & Eck, 2011). The concept of situational crime prevention was first introduced in 1980 by Ronald Clarke as an alternative to traditional criminological approaches to crime prevention. Clarke (1980) argued that criminal acts depend on situational factors, regardless of individuals' criminal disposition. According to Clarke, changing criminal dispositions is practically impossible because rehabilitation is difficult, and trying to eliminate the root causes of crime is unfeasible. Therefore, manipulating situational factors is the most practical strategy to prevent crime (Clarke, 1995). Clarke (1983) argued that crime involvement decisions are rational because individuals weigh the costs and benefits of committing a crime. Thus, prevention strategies could change the offender's decision-making process by manipulating the immediate environment and altering the perceived benefits and costs of crime (Clarke, 1983; Tillyer & Kennedy, 2008). Unlike the generic approaches to crime prevention, which apply various techniques to a broad range of problems, situational crime prevention focuses on a precise problem, in a specific place, under particular circumstances, and it uses this information to devise ways to make the target unattractive to criminals. In this regard, Brantingham and Brantingham (2005) and Cornish and Clarke (2003) identified some factors which include removing excuses, increasing risks and

efforts, and reducing rewards and provocations, that could be leveraged to persuade potential offenders that committing a particular crime would be a bad decision.

Preventing Forgery and Document Fraud

While crimes such as burglary and robbery have received a vast amount of attention by environmental criminologists (Bernasco & Block, 2009; Bernasco & Block, 2011; Bernasco & Luykx, 2003; Braga, Hureau, & Papachristos, 2011; Brown & Bentley, 1993; Coupe & Blake, 2006; Coupe & Blake, 2011; Garcia-Ratamero & Dhami, 2009; Jacobs, 2010; Palmer, Holmes, & Rollins, 2002; Tilley, Tseloni, & Farrell, 2011; Tseloni, Wittebrood, Farrell, & Pease, 2004; Wright, Logie, & Decker, 1995), other crimes have received little attention. Considering the tremendous impact that forgery and document fraud have on society, it is surprising that these kinds of crimes are rarely discussed in the environmental crime literature. In fact, only a few articles related to forgery and document fraud (Knutsson & Kuhlhorn, 1992; Levi, 1998; Levi, Bissell, & Richardson, 1991; Lacoste & Tremblay, 2003; Masuda, 1996; Mativat & Tremblay, 1997; Newman, 2003; Smith, 1997; Tremblay, 1986; Webb, 1996) were found after conducting a review of this literature, and a majority of these studies focused on credit card fraud. Furthermore, most of these articles were written at least 15 years ago, and many aspects of society have changed since then. Unlike robbery and burglary crimes, which employ prevention strategies that were effective 15 years ago and still are today (Coupe & Blake, 2011; Felson & Boba, 2010; Wright & Decker, 1996; Wright & Decker, 1997), crimes that are greatly impacted by changes in technology must be investigated regularly so that researchers and practitioners can keep pace with the criminals and devise crime prevention strategies that are relevant to the problem at hand. For example, the expansion of the Internet and society's dependence upon it has changed the way in which some crimes are committed, and social media sites such as

Facebook and Twitter have created new kinds of crimes for law enforcement and security professionals (Giles, 2013; Griggs, 2012; IC3, 2011; Peachey, 2012). The same is true for forgery and document fraud. Although forgery is an old type of crime and the handwriting identification process has remained unchanged, the technology used to create documents and complete financial transactions has changed (Iannacci & Morris, 2000). For instance, high quality fake identity documents can be created without difficulty using inexpensive computer software and printers that are readily available to the general public (Fenoff & Spink, 2013). Furthermore, the rapid advances in technology have resulted in paperless documents requiring electronic signatures. To ensure the validity and legal effect of contracts entered electronically (PL 106-229, 2000), Congress enacted the Electronic Signatures in Global and National Commerce Act ("ESIGN") on June 30, 2000, which facilitates the use of electronic records and signatures in interstate and foreign commerce.

In his book, *Crime and Nature*, Marcus Felson (2006) stated that in order to understand crime, one should always ask how being watched impacts an offender's behavior. Forgery crimes and document fraud require, in most situations, the direct interaction between the offender and the guardian. Therefore, it would seem as though an active guardian would play a vital role in detecting and deterring forgery and document fraud crimes. However, criminal justice and criminology scholars' understanding of how an offender behaves in the presence of a guardian, and how the latter may prevent forgery and/or document fraud, is extremely limited due to a lack of research in this area. Consequently, further research on how environmental criminology and guardianship can be used to explain forgery and document fraud would contribute greatly to the literature on environmental criminology.

Offender-Guardian Relationship

Some scholars argue that routine activity theory has attracted the attention of researchers who have focused on target suitability and offender motivation, but have overlooked capable guardianship (Knutsson & Clarke, 2006; Sampson et al., 2010). This is surprising considering that guardianship is the most important component of the crime event model, as suggested by Felson and Boba (2010). Indeed, by disrupting the interaction between a motivated offender and a suitable target, a guardian can directly or indirectly prevent a crime from occurring (Hollis-Peel, Reynald, van Bavel, Elffers, & Welsh, 2011).

From its original conception, guardianship has evolved into three types: handlers, managers, and target-guardians (Sampson et al., 2010), which collectively are referred to as controllers. Handler-guardians are those individuals who have an emotional connection to the offender, and can be a parent, sibling, friend, school teacher, or religious leader (Eck, 1994; Felson, 1995; Felson & Boba, 2010; Sampson et al., 2010; Tillyer & Eck, 2011). Manager-guardians are individuals who are responsible for controlling and monitoring behavior at specific places, such as store clerks, landlords, home owners, bank tellers, waitresses, flight attendants, and janitors (Eck, 1994; Sampson et al., 2010). Target-guardians are those individuals who protect targets. They are the most widely studied and discussed form of guardianship, and they include ordinary citizens and groups of people who may or may not be known to the target of the crime, for example, a neighbor (Sampson et al., 2010).

Taking into consideration this new concept of guardianship, Eck (1994; 2003) proposed that the "crime triangle" should consist of two layers (Figure 1): the inner layer representing the three elements necessary for a crime to occur and the outer layer representing the three types of guardians (controllers) that may prevent a crime. According to Eck (2003), the intervention of

any one controller can be enough to prevent a crime from taking place. Felson and Boba (2010) asserted that the three forms of guardianship are interconnected in the sense that a crime is accomplished when a motivated offender moves away from handlers, toward a place without a manager, and a target without a guardian.

Figure 1. The Crime Triangle

Adapted from Clarke and Eck, 2009

While the studies that have been conducted on guardianship have improved criminal justice and criminology scholars' understanding of the guardians' role in crime prevention, they have done so in a narrow way. Most of these studies have focused on target-guardians and their role in preventing specific types of property crime (e.g., burglary, robbery, auto-theft). Although research on property crime has consistently shown that target-guardianship is an important factor in reducing the likelihood of crime (Barclay, Buckley, Brantingham, Brantingham, & Whinn-Yates, 1996; Barclay & Donnermeyer, 2011; Bennett, Holloway, & Farrington, 2006; Bernasco & Luykx, 2003; Brown & Bentley, 1993; Coupe & Blake, 2006; Felson, 1995; Felson, 2006; Garofalo & Clark, 1992; Lynch & Cantor, 1992; Madensen & Eck, 2008; Pennell, Curtis, Henderson, & Tayman, 1989; Reynald, 2009; Reynald, 2010; Reynald, 2011a; Wilcox,

Madensen, & Tillyer, 2007; Wortley & McFarlane, 2011; Wright & Decker, 1996), some scholars have realized that effective target-guardianship requires more than the simple insertion of a warm body for surveillance purposes (Kenney, 1986; Reynald, 2010; Reynald, 2011a; Tilley, & Webb, 1994; Welsh, Mudge, & Farrington, 2010). According to Lynch and Cantor (1992), active monitoring is a crucial component of capable target-guardianship. In a study of residential burglary conducted by Brown and Bentley (1993), the authors found that in some cases the risk of being seen was not sufficient to deter burglars; they also needed to know that the potential onlookers cared enough about their presence to intervene. Brown and Bentley's observation that active guardianship is necessary to prevent crime has been further supported by other researchers. For instance, Reynald argued that monitoring alone is not good enough to prevent and deter crime over the long run; the guardian must be willing to intervene when necessary (Reynald, 2010; Reynald, 2011b).

A good analogy of the necessity of active guardianship is the scarecrow. The scarecrow was created to act as a physical deterrent to crows and other birds that would destroy a farmer's crops. However, if the scarecrow remains in the same location and position for too long, the crows eventually learn that it is not a real threat, so they ignore it and attack the crops. Likewise, in the event of a crime, a guardian (e.g., a neighbor) may act as an initial deterrent to some burglars, but if the guardian is not willing to intervene, the deterrent effect will eventually wear off and a burglary will be more likely to occur. Similar observations have been reported in studies conducted on shoplifting and the effectiveness of closed circuit television (CCTV) surveillance cameras (Carroll & Weaver, 1986; Farrington, Bowen, Buckle, Burns-Howell, Burrows, & Speed, 1993; Phillips, 1999; Welsh & Farrington, 2009). Although environmental criminology has advanced the understanding of crime and crime prevention in many remarkable

ways, the current knowledge on guardianship comes from research focused primarily on crimes such as burglary, robbery, theft, shoplifting, and auto-theft, which have received a lot of attention from environmental criminologists. However, there is no evidence indicating that the offender-guardian relationship in these crimes is similar to the one in other types of crimes. Furthermore, the literature on guardianship fails to address how guardians can prevent crime in situations when they must interact with the offenders. One of the central tenets of guardianship is that crime is more likely to happen when a guardian is absent than when she or he is present (Felson, 1995). This is because the guardian's presence acts as a reminder to the offender that someone is watching, thus she or he avoids carrying out the offense (Felson & Boba, 2010). However, in forgery and document fraud crimes, the offender often interacts directly with the guardian, thus the traditional views of guardianship are insufficient in understanding and explaining those crime problems that occur in places where the guardians directly interact with the offenders. Indeed, an offender who is planning to forge a document expects to interact with a "watchful" guardian. Therefore, the guardian's role cannot only be to prevent the forgery and/or document fraud crime from happening, but also to alter the offender's behavior in such a way that the risk of him/her being caught after committing the crime increases considerably. Consequently, in order to understand how guardians influence the forgery and document fraud crimes that happen at specific places, the current definitions of guardianship must be expanded upon to include individuals who often have to directly interact with the undeterred offender.

Capable Guardianship and Increasing the Offender's Risk of Being Caught

Traditionally, the definition of guardianship has acknowledged the role of target-guardians in preventing crimes. In their groundbreaking article, which introduced routine activity theory to the field of criminology, Cohen and Felson (1979) operationalized (or

measured) guardianship by a person's participation in the labor force and living in a single-adult household. This way of operationalizing guardianship allowed the authors to test their hypothesis that, "the dispersion of activities away from households and families increase opportunities for crime, which results in higher crime rates" (Cohen & Felson, 1979, p. 588). In other words, individuals who are employed outside of the home and who are living in single-adult households are less likely to spend time at home, which results in a higher rate of victimization.

Shortly after their 1979 article, Felson and Cohen (1980, p. 392) defined guardianship as "any spatiotemporally specific supervision of people or property by other people which may prevent criminal violations from occurring." Since then, guardianship has been defined in numerous ways and multiple variables have been identified to operationalize it. The various ways in which guardianship has been defined and measured in the environmental crime theory literature are shown in Appendix A. Guardianship was defined and measured in a relatively consistent manner in the first 25 years after Cohen and Felson (1979) first introduced this concept. During this time, many researchers emphasized the effectiveness of individuals or objects in preventing crime when defining guardianship (Cohen & Cantor, 1980; Cohen, Kluegel, & Land, 1981; Eck & Weisburd, 1995; Felson, 1995; Lynch, 1987; Tseloni et al., 2004). While individuals could be housewives, friends, neighbors, private security, police officers, or pedestrians, objects could be burglar alarms, locks, barred windows, cameras, or other devices that can prevent or inhibit victimization. In those studies where guardianship was not clearly defined, the manner in which the researchers operationalized this concept in order to understand how they viewed it was analyzed. For example, Stahura and Sloan III (1988) measured guardianship by female labor force non-participation, police expenditures, and police employment, while Bennett (1991) measured it by female labor force participation. Meithe,

Stafford, and Sloane (1990) used the number of people in the household and daytime and nighttime activity, while Garofalo and Clark (1992) measured guardianship by household occupancy and the presence of lighting, dogs, alarm systems and neighborhood watches. Rice and Smith (2002) looked at the number of owner-occupied places, the number of multifamily buildings, the number of single-parent homes, and the number of commercial places. Coupe and Blake (2006) used occupancy of housing at the time of burglary, detection of the burglary (i.e., reporting the crime), and security devices. Although these authors did not all directly define guardianship, they operationalized the concept in a way that is consistent with how it has been defined. Later on, Felson (2006) re-defined guardianship and identified guardians as ordinary citizens (i.e., anyone who passes by or is specifically asked to act as a guardian), who keep an eye on potential targets of crime.

More recently, a guardian has been defined as "someone whose presence serves as a gentle reminder that someone is looking or those who engage in natural surveillance, including ordinary citizens going about their daily lives but providing by their presence some degree of security" (Felson & Boba, 2010, p. 28). Guardians have also been described as "crime control agents who are most likely to assume primary responsibility for their residential space, including the people and property contained therein" (Reynald, 2010, p. 363). Although these definitions are more refined than previous ones, they are still consistent with the research that has been completed on guardianship over the last 35 years and have two common key components: (1) the supervision of people or property by other people, and (2) the prevention of crime. As a result, most of the research that has been conducted on guardianship is related to target-guardians and their influence on specific property crimes (e.g., burglary, robbery, car theft, shoplifting).

Even though the original conceptualization of guardianship has been expanded upon in the last 35 years, the way it has been studied and defined during this time has remained relatively the same[11]. In this regard, the focus has largely been on target guardians and traditional crime problems (burglary, robbery, auto-theft, theft, and shoplifting), and other forms of guardianship (handler-guardians and manager-guardians) have been rarely considered.

Hollis-Peel, Reynald, van Bavel, Elffers, and Welsh (2011, p. 57) attempted to refine the guardianship construct by proposing the following formal definition of guardianship: "A guardian is any person and every person on the scene of a potential crime that may notice and intervene (whether they intend to or not)." While the authors' definition (which includes the formal guardians, handlers, managers, and target guardians) is consistent with previous definitions of guardianship, it is problematic in two ways: (1) it is too general to explain guardianship in a meaningful way, and (2) it does not fully acknowledge the importance and role of handler-guardians and manager-guardians who, according to Felson and Boba (2010), may have the most important guardianship role of the three types (handler-guardians, manager-guardians, and target-guardians). Later, Hollis, Felson, and Welsh (2013, p. 76) proposed, what they considered to be, a clear definition of guardianship for use in routine activity theory. They defined guardianship as, "the presence of a human element which acts, whether intentionally or not, to deter the would-be offender from committing a crime against an available target." While this definition of guardianship appears to be more concise than previous versions, its focus is on deterring offenders. As a result, other key elements of guardianship are overlooked. For example, some crimes (e.g., forgery and document fraud) require the offender to interact with the guardian in order to carry out the crime. Therefore, a more focused definition of guardianship will be

[11] Some exceptions include Reynald's Guardianship In Action and the introduction of controllers and super-controllers (Sampson et al., 2010).

helpful when studying specific kinds of crimes, and the role that specific types of guardians play in preventing crime.

According to environmental crime theorists, the tenets of routine activity theory and situational crime prevention are all about focusing on specific types of crime. For example, someone studying the five different types of signature forgery (simple, simulation, tracing, cut-and-paste, and auto-forgery) will find that each one has different patterns. The same is true when studying guardianship. There are different kinds of guardians, and their effect on the offender may vary depending on the type of crime, where it takes place, and the capability (real or perceived) of the guardian. Considering this, having so many different definitions of guardianship (Appendix A) creates a problem when trying to understand a guardian's role in preventing crime.

Since a focused approach to crime prevention requires a comprehensive understanding of the specific types of crime being studied, it is crucial to understand the impact that handler-guardians and manager-guardians have on crime. In his classic article on situational crime prevention, Clarke (1980) argued that it is possible to prevent crime by increasing the risks of being caught. This can be accomplished by increasing the chances of an offender being seen by someone who is likely to intervene. Although this idea still holds true today, the purported deterrent effect of being seen by a guardian is not as strong in crimes like forgery and document fraud. Since most times the offender will be unable to complete the fraud (e.g., cash a forged check, pass a fake document, or disguise a signature on a receipt) without a guardian approving the transaction, it is the extent and nature of the interaction between the offender and the guardian that is important. The offender knows that to reap the benefits of the fraud, she or he must first get the fake document or disguised signature past the guardian. The offender and

guardian then play a psychological game in which the guardian "watches" the offender, and the offender tries to predict the forgery detection abilities of the guardian. If the guardian is well trained in forgery detection, then the offender's risk of being caught in the act is much higher than if the guardian is inept or just does not care at all. Furthermore, the offender must make a judgment as to the guardian's forgery detection ability and adjust his/her behavior accordingly, which requires taking calculated risks (Buckner & Carroll, 2006; Cornish & Clarke, 1986; Jacobs & Wright, 2010). This battle between offenders and guardians has been noted elsewhere. In a study of shoplifters, Carroll and Weaver (1986) found that a change in behavior by sales personnel can alter the strategies used by shoplifters. The authors argued that this "battle in the aisles" between shoplifters and retailers is won or lost depending on the activity and commitment of store employees. In forgery and document fraud crimes, it is rare for an offender to be caught in the act unless a well-trained guardian is present. However, even if the guardian is not proficient at detecting these kinds of crimes, if the offender perceives the guardian to be well trained, she or he may be less likely to commit forgery or document fraud. Indeed, guardian capability may be less important than guardianship credibility (Tilley, 2009). Furthermore, if the offender remains undeterred and commits the crime, his/her chances of being identified increase considerably. For example, an individual who enters a bank with the intention of disguising his signature to withdraw money from his account to later deny making the withdrawal must first make a judgment decision as to the forgery detection ability of the bank teller. If he perceives the bank teller as a capable guardian, in the sense that she will carefully evaluate the signature, then his disguise strategy may only be a slight deviation from his normal signature in order to get it past the bank teller. However, once this signature becomes part of a forgery investigation, the investigator will have enough evidence (i.e., comparable handwriting features) to complete a

thorough forensic analysis of the signature and make a determination regarding its authenticity. Therefore, a prevention strategy that involves the alteration of the offender's behavior by the guardian increases the risks of the offender being caught. In this regard, the evidence left behind by the offender will assist investigators in making the appropriate charging decisions.

To expect businesses, law enforcement, and security professionals to prevent all forgery and document fraud crimes is unrealistic. No matter what prevention strategies are employed, there will always be undeterred offenders who will successfully pass forged and fake documents for personal gain. However, by manipulating the guardian's role, some prevention strategies can be used to alter the undeterred offender's choice of disguise strategy or forgery technique. Altering the offender's decision-making process in a way that makes the handwriting a useful piece of evidence in identifying the offender will tip the scale in favor of the victim and the investigatory team (police, forensic document examiner, security personnel). Thus, the notion of capable guardianship must be expanded upon to include not only deterring crime, but also altering the behavior of undeterred offenders in such a way that they leave physical evidence behind that increases the chances of identifying them. In this regard, a capable guardian can be defined as an individual(s) whose presence either prevents a crime from occurring or alters the undeterred offender's behavior in such a way that a useful form of evidence is left behind at the crime scene, enabling investigators to identify the offender at a later date. In other words, the guardian's primary task is to prevent the crime from taking place, and the secondary task is to alter the behavior of the undeterred offender.

Combining environmental crime theories with technical knowledge of forgery and document fraud (i.e., a forensic practitioner's perspective) can help scholars and practitioners better understand these crimes. This deeper understanding will promote the development of more

effective crime prevention strategies and improve the investigatory and forensic analysis techniques being used. Crime prevention strategies should integrate behavior alteration techniques so that the few undeterred offenders have an increased risk of being identified after the crime has been committed. The current study attempted to combine crime prevention strategies with forensic technical knowledge to better understand the crime of forgery and document fraud.

CHAPTER 4: METHODOLOGY

The data used in the current study, which came from a secondary data source, were collected using the methods described below. The methodology section was divided into four parts. First, the research questions and the operationalization for level of guardianship were presented. Second, the survey questionnaire used in this study was discussed. Third, the research design and sampling strategy were reviewed. Fourth, the procedures and coding scheme were examined.

Research questions

Handwriting is the result of a complex perceptual-motor skill that becomes habit-formed over time (Caligiuri & Mohammed, 2012; Huber & Headrick, 1999). Therefore, it is extremely difficult for individuals to intentionally change several features of their handwriting while also trying to maintain some degree of pictorial similarity. This is because they must consciously suppress habit while also concentrate on those specific aspects of their handwriting that they want to change. Consequently, the best disguise strategy would be to make only minor, but notable, changes that could support the author's contention of different authorship. Unfortunately, the amount and kind of handwriting features (Appendix G) that writers alter when disguising their signature cannot be thoroughly identified given the enormous gap in the forensic document examination literature regarding signature disguise. Furthermore, the threats to validity and reliability, which plague the few disguised handwriting studies that have been completed, weaken the studies' findings and limit their generalizability. The 2009 NAS report on strengthening forensic science in the United States acknowledged this problem, and stressed the need to increase and improve the quantity and quality of the research studies on handwriting identification (National Research Council, 2009).

The goal of this study was to determine how many and what types of changes typically result when a writer employs a disguise strategy. This information will provide investigators (i.e., forensic document examiners, police officers, security professionals, etc.) with a comprehensive list of the primary (intended handwriting changes) and secondary (unintended handwriting changes) features that result from disguise. Additionally, this knowledge will assist them in determining whether a questioned signature is the result of disguise or different authorship. To further the current knowledge on disguised handwriting, the role of guardianship, and the strategies that can be used to prevent forgery crimes and document fraud, eight research questions were addressed. The first four questions, which investigated the forensic aspects of disguised handwriting, were as follows:

Q 1: What are the primary disguise strategies used by individuals who purposely alter their signature with the intention of later denying ever signing a document?

Q 2: How many handwriting features do writers attempt to change when disguising their handwriting?

Q 3: What are the unintentional (i.e., secondary) handwriting changes that occur as a direct result of the author's intentional changes?

Q 4: How successful are writers in executing their intended disguise strategy?

The remaining four research questions explored the effect that the level of guardianship (i.e., how thoroughly the guardian evaluates the signature) had on the interaction between the offender and the guardian in forgery and document fraud crimes. In this regard, environmental crime theories suggest that the presence of a guardian reduces crime because it decreases the opportunities to offend (Cohen & Felson, 1979; Felson & Clarke, 1998). However, in certain kinds of crimes, the presence of a guardian may not be enough to deter an offender from

engaging in criminal behavior; the guardian must also be perceived by the offender as capable and skilled. In the case of forgery crimes and document fraud, it is unclear how offenders determine capable guardianship. To gain a better understanding of how offenders interpret and adapt to different levels of guardianship, and to develop effective prevention strategies, the following questions regarding the offender-guardian relationship were investigated:

Q 5: Does the writer's disguise strategy change depending on the level of guardianship?

Q 6: If yes, how does it change?

Q 7: What is the writer's thought-process when choosing a specific disguise strategy?

Q 8: Why do writers choose a specific disguise strategy?

Operationalization for Level of Guardianship

The variable, *level of guardianship,* was operationalized by how thoroughly the guardian evaluated the writer's signature. For the purpose of this study, there were three scenarios, each one with a different level of guardianship; low (scenario 1), medium (scenario 2), and high (scenario 3). A low level of guardianship was represented by a guardian who did not evaluate the signature thoroughly. A medium level of guardianship was represented by a guardian who may or may not have thoroughly evaluated the signature, and a high level of guardianship was represented by a guardian that thoroughly evaluated the writer's signature.

Survey Questionnaire

A survey questionnaire (Appendix B) was developed to identify and better understand the thought process and techniques used by individuals who, under different levels of guardianship, disguised their signature. The survey questionnaire consisted of three parts.

Part I

Part I of the survey questionnaire was designed to elicit specific information about the

participants' views and beliefs regarding the forgery detection ability of the guardians (i.e., cashiers, bank teller, waitresses) at well-known local businesses, which were chosen based on their popularity with the study's population (college students). Meijer, Wal-Mart, Kroger, K-Mart, and Target were selected to represent local retailers. Olive Garden and Old Chicago were selected to represent local restaurants, and the MSU Federal Credit Union (FCU) was the bank example. This part of the questionnaire served two purposes. The first purpose was to understand the participants' perceptions regarding the forgery detection ability of cashiers/waitresses/bank tellers (guardians) at these businesses, and the second purpose was to give participants the opportunity to reflect on their experiences regarding their signatures being examined by cashiers/waitresses/bank tellers when they visit these business establishments. Knowing what participants think a guardian looks for when evaluating a signature and how they determine the guardian's ability to detect a forgery will help criminal justice scholars and practitioners understand the hypothesized self-projecting behavior that writers use when devising a disguise strategy. For instance, if a participant believes that the bank tellers at the MSU FCU are better trained in forgery detection than the cashiers at Meijer, it would be expected that the participant's disguise strategy under the bank scenario would be different than the strategy used in the retail store scenario. Furthermore, giving participants the opportunity to share what they think about the guardians' forgery detection ability at different businesses and what they believe the guardians look for when examining a signature, will further scholars' and practitioners' knowledge of how people's disguising strategies are influenced by their perception of the situation under which they sign a document.

Part II

Part II of the survey questionnaire consisted of six short-answer open-ended questions;

two for each of the three study scenarios. These questions were designed to allow participants to identify and describe the handwriting changes that they made when asked to disguise their signature, and explain why they chose a specific disguise strategy. This information was then used to determine whether or not study participants were successful in executing their intended disguise strategy, how many different intentional changes were made, and the effect that the participants' perceived levels of guardianship had on their disguise strategy.

Part III

This part of the survey questionnaire was designed to gather demographic information about the participants. These demographic variables included age, gender, race, country of citizenship, handedness, and education. Three questions were also included that addressed the participants' experience with the handwriting identification process. To control for those participants who might have received some training or who had experience in forgery detection, participants were specifically asked if they had any training in forensic handwriting analysis or forgery detection, and whether or not they had ever been victims of forgery or identity theft. If a participant had been a victim of forgery or identity theft, she or he may have learned some of the features that investigators look for when evaluating signatures. This inside knowledge could have potentially influenced their disguise strategy.

Research Design

The one-group pretest-posttest quasi-experimental design was used. This research design is structurally represented as follows:

O1 X O2

Where O1 is the pretest, X is the treatment, and O2 is the posttest.

Sample Strategy

A non-probability purposive sample of college students was chosen. Despite the long-standing controversy among scholars regarding the use of students as subjects, there is a dearth of empirical evidence either supporting or refuting the notion that college students are different from non-college students in their behavior and attitudes (Peterson, 2001). However, much of what is known about human behavior comes from the field of social psychology, which has relied primarily on young American college students tested in university laboratories (Bargh, Chen, & Burrows, 1996; Chartrand & Bargh, 1999; Darley & Batson, 1973; Darley & Latane, 1968; Deutsch & Krauss, 1962; Festinger & Carlsmith, 1959; Gilbert, Tafarodi, & Malone, 1993; Sears, 1986; Stasser & Tutus, 1985; Tajfel, Billig, Bundy, & Flament, 1971; Wegner, Schneider, Carter, & White, 1987). Some classic studies on human behavior that have used students as subjects include: Milgram's (1963) behavioral study of obedience; Zimbardo's Stanford Prison Study (Musen & Zimbardo 1991); Asch's (1951) group pressure study; Ross, Greene, and House's (1977) research on the false consensus effect; Snyder, Tanke, and Berscheid's (1977) experiment on the self-fulfilling nature of social stereotypes; Nisbett and Cohen's (1996) culture of honor work which investigated the psychology of violence in the south; and Quattrone and Tversky's (1984) study of self-deception. In fact, according to Payne and Chappell (2008), the use of student subjects in the fields of psychology and social psychology is so common, that many colleges and universities have specific policies as to how students in these courses and degree programs can participate as subjects in research studies. Other disciplines that have also incorporated the use of students as study subjects include information-systems, sociology, political science, and criminal justice (Compeau, Marcolin, Kelley, & Higgins, 2012; Jiang, Lambert, & Wang 2007; Koehler & Thompson, 2006; Payne & Chappell, 2008; Wiecko, 2010;

Williams, Fletcher, & Ronan, 2007). The purpose of showing the precedent established by prior studies and emphasizing Payne and Chappell's (2008) point regarding the widespread use of student subjects in social research was to illustrate that much can be learned from using students as research subjects.

The decision to use college students as research subjects in the current study was made after taking into consideration various factors. First, students have been legitimately used in social research. Second, because financial resources were not available to conduct this study, cost and convenience had to be considered. In order to obtain a relatively large sample size without having to offer participants any kind of financial incentive or compensation, using college students appeared to be a feasible option. Finally, to alleviate some validity concerns, a literature review on how college students differ from non-college students on factors related to crime, criminology, behavior, and attitudes was performed. Considering that only a few empirical studies evaluating the use of student subjects in research have been completed, the literature review returned some interesting and encouraging results. In a study conducted by Flere and Lavric (2008) on the validity of cross-cultural social studies using student samples, the authors found that with regard to various sociological and psychological measures, student samples can be used in cross-cultural studies because they are relatively reliable predictors of general cross-cultural differences. Furthermore, in a critical review of criminological studies using student subjects, Payne and Chappell (2008) concluded that even though students cannot and should not be used in all criminological research projects, there are certain types of studies that are particularly responsive to college student samples. Some notable examples were tests of criminological theory and studies that assessed student attitudes and behaviors. In a more recent empirical study of student sample validity, Wiecko (2010) found that questions surrounding the

validity of student samples may not be as warranted as once thought. In fact, when compared to non-college students, the author reported almost no statistically significant difference in behaviors, and reported only minor differences in the frequency of behaviors and attitudes. Because college students are a convenient source of information, and they are also closely representative of the rest of the population when it comes to criminal and delinquent acts, Wiecko (2010) encouraged their use. In concluding the article, the author asserted that while college students may be culturally unique, this uniqueness does not seem to affect validity. In light of these findings, the use of student subjects was appropriate for the current study.

When selecting the sampling method, various factors and challenges surrounding the study were considered. First, although the random selection of a sample is considered to be the gold standard in research design, it is not always the most efficient and cost-effective method (Gravetter & Forzano, 2012). For this study, obtaining a random sample of Michigan State University (MSU) students was possible, but getting a large number of them to volunteer an hour or more of their time to complete a handwriting exercise and travel to and from the study location without any incentive or compensation was difficult. Therefore, a non-random purposive sample, which consisted mainly of students from the Introduction to Criminal Justice class, (and a few students from the Criminal Justice and Forensic Science Graduate Programs), was considered. This particular class was selected for three primary reasons. First, the Introduction to Criminal Justice course typically enrolls 600 students who are divided in three sections of approximately 200 students. With a class this size, obtaining a large sample was convenient. Second, the fact that this class was composed of criminal justice and non-criminal justice students provided diversity to the study sample. Third, students were offered extra credit points to incentivize their participation.

Since college students typically fall within the peak age group for criminal activity (Hirschi & Gottfredson, 1983), a non-probability purposive sample of college students was selected to participate in this study. More specifically, three hundred and eight college students from MSU in East Lansing, Michigan were selected to participate. All of them were interviewed during independent sessions that lasted approximately 30 minutes. Table 1 shows the demographic characteristics of study participants. The participants included 156 males (51%) and 152 females (49%). The self-reported race/ethnicity of the participants included 74% White, 8.1% Asian, 8.1% Hispanic, 7.1% Black, .3% American Indian or Alaska Native, .3% Native Hawaiian or Other Pacific Islander, and 1.9% identified themselves as "Other." A majority of the study participants were between the ages of 17 and 24 (93.2%), followed by 25–30 (4.5%), 31–35 (1.3%), and 36 or older (.9%). The sample was composed of graduate (8%) and undergraduate students (92%) that represented seventeen different countries from five different geographic regions with 91% from North America, 5% from Asia, 2% from Europe, 1% from Mexico and the Caribbean, and 1% from Africa. The diversity of majors represented in the sample was quite impressive considering that it included students majoring in the social sciences (62.7%), business (12%), arts and humanities (6.5%), biological sciences (6.5%), forensic sciences (2.6%), physical sciences (1.9%), education (1%), and other (6.8%).

Table 1. Descriptive statistics for sample population

Variable	Total (N=308)	Percentage
Gender		
Male	156	51
Female	152	49
Race / Ethnicity		
White-Non Hispanic	228	74
White-Hispanic	25	8.1

Table 1 (cont'd)

Asian	25	8.1
African American or Black	22	7.1
American Indian or Alaska Native	1	0.3
Native Hawaiian or Other Pacific Islander	1	0.3
Other	6	1.9
Age Range		
17-24	287	93.2
25-30	14	4.5
31-35	4	1.3
36 or older	3	0.9
Geographic Region		
USA or Canada	282	91.6
Asia	15	4.9
Europe	6	1.9
Mexico and Caribbean	3	1.0
Africa	2	0.6
Highest Degree Earned		
High School Diploma	275	89.3
Bachelor Degree	14	4.5
Master Degree	11	3.6
Associate Degree	8	2.6
Major		
Social Science	193	62.7
Business	37	12
Art & Humanities	20	6.5
Biological Science	20	6.5

Table 1 (cont'd)

Forensic Science	8	2.6
Physical Science	6	1.9
Education	3	1
Other	21	6.8
Degree Pursuing		
Bachelor	283	91.9
Master	12	3.9
PhD	13	4.2

Procedure

Students who volunteered to participate in this study were asked to choose a date and time that was convenient for them to complete the exercise at Baker Hall, located on the MSU campus. Upon arrival, participants were asked to read and sign a consent form (Appendix C). After signing the consent form, they were informed that the survey questionnaire consisted of three sections, and they were encouraged to ask questions if they were unsure about what they were being asked to do in each section. As the participants received the first part of the survey questionnaire (Appendix B), their attention was directed to questions 4 through 12. Participants were then told that although the business examples in those questions were chosen because of their popularity among college students, if they were unfamiliar with them, they could cross them out and replace them with similar businesses in the Lansing area that they were familiar with. For example, a retailer (Meijer, Walmart, Target, K-Mart) could be replaced with another retailer, and a restaurant (Olive Garden, Old Chicago) could be replaced with another restaurant. Participants were also instructed to ask for validation of their replacement example if they were unsure about its appropriateness. Although this situation was not recurrent, it did happen with

some international students. For example, a participant from China who was unfamiliar with Old Chicago replaced this example with another restaurant he was familiar with. After completing this part of the survey, participants were asked to place it face down on their desk and were informed that they were now moving onto a handwriting exercise. Participants were then given the following instructions:

> I am going to give you three different scenarios. After hearing each scenario, I want you to take a minute to think about the strategy that you will use to disguise (alter) your signature in such a way that, (1) you will be able to get it past the guardian (i.e., the person who will be taking your signature), and (2) also be able to later deny ever signing the document. Because each scenario is different, I would like you to think about them independently and base your signature disguise strategy on the scenario at hand.

The scenarios[12] were designed to simulate three commonly encountered situations in which the chances of signatures being compared increase with each situation. In the first scenario, represented by a restaurant setting, participants were led to think that their known and disguised signatures would not be compared. In the second scenario, represented by a retail store setting, participants were led to believe that it was uncertain if their signatures would be compared. In the third scenario, represented by a bank setting, participants were led to think that their signatures would definitely be compared. Although the guardianship characteristics between a retail establishment and a restaurant setting may appear to be similar, the differences in the level of guardianship in each are remarkable. For example, in a restaurant, after a customer finishes his/her meal, the guardian (waiter or waitress) often leaves the check with the customer

[12] The measures of guardianship and the scenarios that were created were drawn from the field of social psychology. This was the first study to use this kind of technique to study how increasing levels of guardianship affect forgery crimes. Furthermore, most of the guardianship research does not pay much attention to manager-guardians. Therefore, there was not much prior research to draw on in terms of constructing scenarios directly from the guardianship literature.

and walks away before the signature is placed onto the document and the transaction is complete. However, in the retail setting, since the guardian never walks away before the signature is added to the sales receipt and the transaction has been completed, the offender has to interact with the guardian when attempting to commit a forgery. This necessary interaction, which is under an uncertain and inconsistent level of guardianship, forces the offender to make an immediate, on-the-spot assessment of the guardian's capability to recognize a forgery on the sales receipt.

It is unknown whether or not the study participants had ever tried to disguise their signature when signing a document with the intention of later denying ever signing it. As a result, a priming technique was used to get participants in the "right-state-of-mind" (Bargh & Chartrand, 2000). They were asked to think in a way out of the ordinary, and to act as though their intent was to truly disguise their signature. Following this instruction, participants were given six documents for each scenario. Each document simulated the kind of receipt/bill/check that they would encounter in each setting (Appendix D). For the restaurant scenario, participants received six identical receipts from Famous Dave's. For the retail store scenario, they received six identical receipts from Wal-Mart. Lastly, they received six identical checks from the MSU FCU for the bank scenario.

For the pretest, participants were asked to sign in their natural handwriting five of the six documents given to them for each scenario and place them face down on their desk. These signatures served as the baseline for how each participant would normally sign his/her name. After giving participants a short narrative (Appendix E) of the specific scenario under which they would disguise their handwriting, they were asked to sign the sixth unsigned document using their chosen disguise strategy. For this posttest portion of the study, the subjects received an additional blank sheet of paper where they could practice their disguise strategy before making

the actual attempt. This process was repeated for each scenario (restaurant, retail store, and bank). Following the handwriting exercise, participants were asked to complete Part II of the survey questionnaire, which asked them specific questions about the disguising strategy that they used for each scenario and the reasons they chose that strategy. Finally, participants were asked to complete the third part of the survey questionnaire, which sought to elicit demographic information about the participants, as well as their experience with crimes of forgery and ID theft.

Coding Scheme

In each of the three scenarios, participants were asked to produce five natural (also referred to as *known*) signatures and one disguised. Therefore, each participant produced a total of fifteen known signatures and three disguised. It has been determined by experts in the field of handwriting examination, that in order to establish a writer's range of natural variation, which is the imprecision with which the habits of the writer are executed on repeated occasions, at least 15 to 20 signatures are necessary for analysis (Conway, 1959; Hilton, 1982; Huber & Headrick, 1999). By asking participants to naturally sign their name five times for each scenario, 15 known signatures were obtained and then used for comparison with the three disguised signatures. This enabled the coder to determine each writer's range of variation and identify the subject's intentional changes.

To code the collected data, a coding scheme (Appendix F) was developed based on the ASTM International standard guide for the examination of handwritten items (2007) and Huber and Headrick's (1999) twenty-one discriminating elements. The coding was completed in two stages. The signatures in the three scenario exercises were coded first, followed by the participants' answers to the questions in Part II of the survey questionnaire. This order was used

to alleviate any bias that could result from coding the participants' self-described intentional handwriting changes before scientifically examining and coding the handwriting changes actually performed[13].

All the signatures were examined using the attached coding scheme (Appendix F), and evaluated using the following steps. First, the fifteen known signatures of each participant were examined and compared to his/her three disguised signatures. The comparison resulted in a list, per participant, of changes associated with each of the scenarios. This list identified all of the handwriting features changed by the participant. Next, the participant's disguise strategy claims for each scenario were reviewed, and a list of the changes that the subject reported making was created. The list of changes that were identified was then compared to the list of the subject's self-identified alterations to answer research questions 1 through 4. After all the signatures of all participants had been examined, three comprehensive lists were created (one for each scenario). These comprehensive lists identified all of the primary (intentional) and secondary (unintentional) handwriting features changed by the participants.

In order to code the success (change) or failure (no change) of the disguise strategies, first, each writer's range of natural variation was determined. This information was used as the baseline measure for the participant's self-reported intentional changes. If a study participant employed a disguise strategy that fell within his or her normal range of writing variation, then the altered handwriting feature was coded as a failure (Figure 2b). Conversely, if the disguise strategy fell outside the writer's range of natural variation, then the changed handwriting feature was coded as a success (Figure 3b).

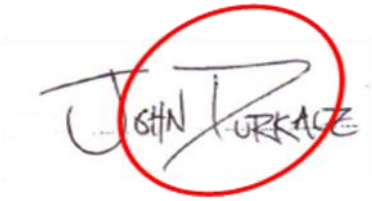
[13] This study investigated how people attempt to disguise their handwriting under different levels of guardianship. In no way did it test an examiner's ability to identify forged/disguised handwriting.

Figure 2a. Naturally written capital letter "S"

Figure 2b. Failed attempt to alter the capital letter "S"

Figure 3a. Naturally written capital letter "D"

Figure 3b. Successfully altered capital letter "D"



The data collected in the first and third part of the survey questionnaire were coded using a numeric coding system, and along with the information obtained in Part II, were used to answer research questions 5 through 8 (which focused on guardianship). In this regard, if the level of guardianship affected the participants' choice of disguise strategy, then observable differences among the three scenarios were expected. For example, in scenario one, participants were led to think that the guardian would not closely scrutinize their signature. As a result, the subjects may have decided to make their signature grotesquely different from their natural one because the guardian was not going to evaluate it, and it would be easier for them to deny signing it at a later date. However, under the third scenario, since subjects were led to think that the guardian would closely scrutinize their signature, then their disguise strategy was likely minor. In other words, it did not deviate too much from their natural signature, so that they could avoid being caught by the guardian.

Analysis Techniques

For the data analysis portion of this project, three primary statistical techniques were used: (1) Chi-Square Test, (2) Tukey-Kramer Pairwise Comparisons, and (3) Exploratory Factor Analysis.

Chi-Square Test of Independence

Chi-square (χ^2) is a common test statistic used to examine the independence of categorical data (Vogt & Johnson, 2011), which can be converted into one of several measures of association. The simplest use of chi-square is to test for statistically significant differences between the observed and hypothesized frequencies of variables presented in a contingency table. The larger the difference between the observed and hypothesized frequencies, the larger the chi-square statistic is. The larger the statistic, the less likely the observed differences are due to chance (Vogt & Johnson, 2011).

In the current study, the chi-square test of independence was used to address research questions 2, 5, 7, and 8. More specifically, to investigate the relationship between the levels of guardianship and the number of handwriting features changed, the disguise strategies used, and how and why the study participants' thought processes were influenced by the scenarios they were presented with. An alpha level of .05 was used for all statistical analyses.

Tukey-Kramer Pairwise Comparisons

Tukey-Kramer Pairwise Comparison is an analysis used to examine all the pairs of means in order to determine any difference between two means (Abdi & Williams, 2010; Tukey, 1949). One advantage of the Tukey-Kramer test is that it keeps the level of Type I errors (i.e., false positive) equal to the alpha level (e.g., $\alpha = .05$). Another advantage is that the test allows for the computation of confidence intervals for the difference between the means (Abdi & Williams,

2010). In the current study, Tukey-Kramer Pairwise Comparisons were used to answer research question 4, which aimed to determine whether or not the participants were successful in executing their intended disguise strategies. In this regard, the participants' self-reported changes, and what was actually noted as being changed during the coding process, were compared and used to assess the statistical significance of the differences in success rates across the scenarios.

Exploratory Factor Analysis

Factor analysis is a method of data reduction that is used to simplify complex sets of data so that relationships between variables can be more easily interpreted and understood (Yong & Pearce, 2013). More specifically, the purpose of factor analysis is to assist researchers in identifying and understanding the nature of the latent constructs underlying the variables of interest so that they can be explained in terms of a few underlying factors (Bandalos & Finney, 2010). Exploratory Factor Analysis (EFA) is typically used in two ways: (1) to explore a specific area of interest in order to discover the main latent constructs or dimensions that reflect the most variation in the data, and (2) to discover if the original variables are organized in a particular way, reflecting another latent variable (Kline, 1994).

According to Bandalos and Finney (2010), many of the decisions made in EFA are subjective, and are made on the basis of congruence with theory and/or previous research. However, some decisions are based on statistical guidelines, such as determining the number of factors to retain (Bandalos & Finney, 2010; Preacher, Zhang, Kim, & Mels, 2013). Most experts agree that EFA should be used for situations in which little research has been conducted regarding the structure of the construct or measure of interest (Bandalos & Finney, 2010; Fabrigar, Wegener, MacCallum, & Strahan, 1999; Tabachnick & Fidell, 2001). Variables used for EFA can take a variety of forms, such as items from a scale or direct measures of subject

characteristics (Bandalos & Finney, 2010). The variables used in this study are non-continuous, but according to Finney and DiStefano (2006), this was not a problem since the items had at least five scale points and were reasonably inter-correlated.

Extraction is the process by which the parameters of the factor solution, which include the factor pattern coefficients, are estimated (Bandalos & Finney, 2010). Although there are many different methods that can be used to conduct a factor analysis, Principal Axis (PA) and Maximum Likelihood (ML) methods are commonly used (Bandalos & Finney, 2010; Kline, 1994). For the current study, PA, which uses a least-squares type solution and attempts to minimize the residuals, was the extraction method used, since it is considered a fairly straightforward method. Several solutions were compared that extracted various plausible numbers of factors. The final number of factors was determined in part by theory, and by running the analysis extracting different numbers of factors in order to see which number of factors yielded the most interpretable results.

Extracted factors are often difficult to interpret on the basis of their factor loadings (Field, 2000). Therefore, the factors are rotated to alter the pattern of the factor loadings so that their interpretation can be improved (Field, 2000). While many rotation methods exist, the primary difference is between those that produce orthogonal (uncorrelated) and oblique (correlated) factors (Bandalos & Finney, 2010). Since it was unknown whether the factors were correlated, both orthogonal (varimax) and oblique (promax) factors were obtained for comparison. In the promax solution, it was generally noted that the factors were not correlated when the minimum criteria for loading was set at $r = .4$, so it was decided that the model using orthogonal rotation provided the most interpretable results. While it is not uncommon for variables to be removed from the model due to low structure, pattern, or communality (Bandalos & Finney, 2010), all

remaining variables were included so that results could be compared between the differences in factor loadings from the baseline condition to the combined guardianship conditions.

To complete the factor analysis, a Principal Axis Factor (PAF) with a Varimax rotation of 28 of 29 items[14] from the handwriting analysis was conducted on the data collected. Prior to the factor analysis, the data were screened for any outliers and missing data. An examination of the Kaiser-Meyer-Olkin measure of sampling adequacy for the baseline condition was performed and found to be factorable (KMO = .591). Bartlett's Test of Sphericity was highly significant $\chi^2 = 1596$, $p < .001$. Initially, 10 factors with eigenvalues greater than one were extruded.

[14] The handwriting variable *speed* was not rotated because it is difficult to determine absolute handwriting speed from a static signature. Therefore, this variable was not coded.

CHAPTER 5: RESULTS

This chapter presents the findings of the current study. All analysis was performed using SPSS v22.0.

Research Question 1: What are the primary disguise strategies used by individuals who purposely alter their signature with the intention of later denying ever signing a document?

A total of 21 handwriting features were purposely changed by the study participants. Table 2 provides a scenario count of these features where each column identifies the total number of study participants that changed the associated handwriting feature. Each participant reported changing one to three features per scenario.

Table 2. Scenario count of the handwriting features that the study participants said they changed

Variable	**Scenario #1**	**Scenario #2**	**Scenario #3**
	N (Column %)	**N (Column %)**	**N (Column %)**
Letter Form	165 (29.46)	157 (29.07)	176 (30.45)
Legibility	119 (21.25)	118 (21.85)	124 (21.45)
Size	69 (12.32)	58 (10.74)	60 (10.38)
Spelling	49 (8.75)	37 (6.85)	51 (8.82)
Spacing	19 (3.39)	28 (5.19)	26 (4.50)
Slant	17 (3.04)	25 (4.63)	21 (3.63)
Abbreviations	18 (3.21)	14 (2.59)	24 (4.15)
Terminal Stroke	11 (1.96)	20 (3.70)	15 (2.60)
Speed	17 (3.04)	15 (2.78)	13 (2.25)

Table 2 (cont'd)

Style of Allograph	22 (3.93)	6 (1.11)	16 (2.77)
Punctuation	9 (1.61)	13 (2.41)	11 (1.90)
Embellishment	11 (1.96)	8 (1.48)	10 (1.73)
Pressure	10 (1.79)	10 (1.85)	3 (0.52)
Hand	2 (0.36)	6 (1.11)	9 (1.56)
Lateral Expansion	6 (1.07)	5 (0.93)	5 (0.87)
Line Quality	5 (0.89)	5 (0.93)	4 (0.69)
Connecting Strokes	3 (0.54)	5 (0.93)	4 (0.69)
Alignment	3 (0.54)	5 (0.93)	2 (0.35)
Initial Strokes	4 (0.71)	1 (0.19)	1 (0.17)
Order of Name	1 (0.18)	1 (0.19)	1 (0.17)
Pen lifts	0 (0.00)	2 (0.37)	1 (0.17)
No Change	0 (0.00)	1 (0.19)	1 (0.17)
Total Responses	560	540	578

Figure 4 illustrates the percentage of participants that altered handwriting features under the three scenarios. It is clear from this graph that although multiple features were intentionally altered, only five were consistently changed by participants in all three scenarios: letter form, legibility (neater and messier), absolute size, spelling, and spacing (see Appendix H for examples of handwriting changes).

Figure 4. Overview of the handwriting features intentionally changed by participants

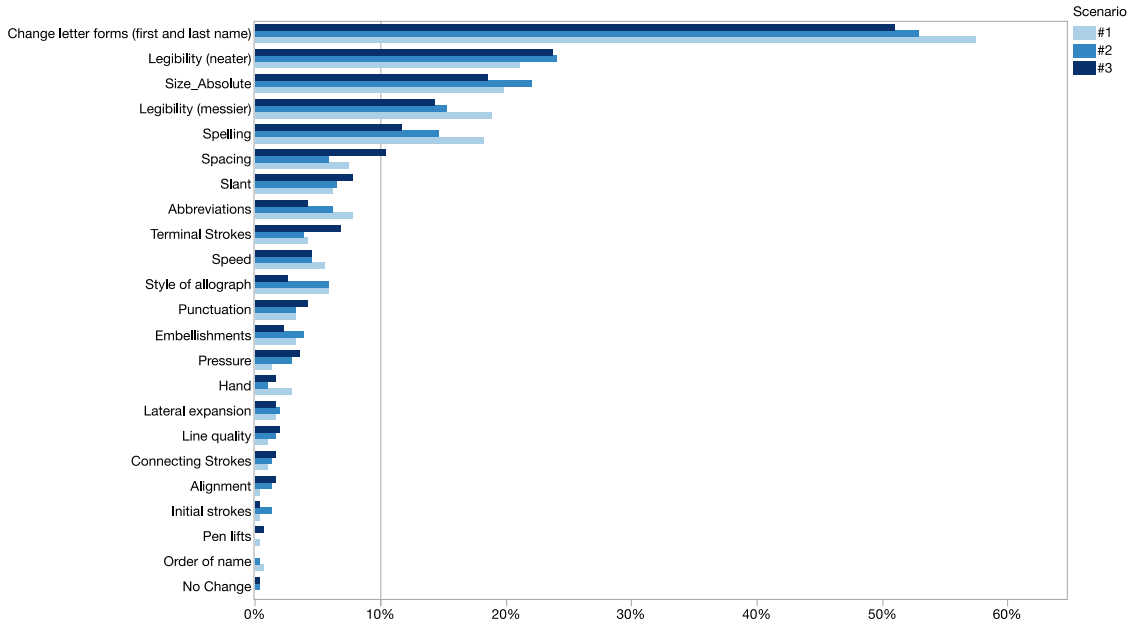


Table 3 shows the number and percentage of participants who changed these five handwriting features, and the scenario under which they did so. For scenario 1, 39.2% of the study participants changed letter form, 28.3% changed legibility, 16.4% changed size, 11.6% changed spelling, and 4.5% changed spacing. A similar pattern was observed for scenario 2 and scenario 3 where 39.4% and 40.3% changed letter form, 29.6% and 28.4% changed legibility, 14.6% and 13.7% changed size, 9.3% and 11.7% changed spelling, and 7% and 5.9% changed spacing, respectively.

Table 3. Top five handwriting features intentionally changed by the study participants

Handwriting Feature	**Scenario #1**	**Scenario #2**	**Scenario #3**
	N (%)	**N (%)**	**N (%)**
Letter Form	165 (39.2)	157 (39.4)	176 (40.3)
Legibility (neater and messier)	119 (28.3)	118 (29.6)	124 (28.4)
Size	69 (16.4)	58 (14.6)	60 (13.7)

Table 3 (cont'd)

Spelling	49 (11.6)	37 (9.3)	51 (11.7)
Spacing	19 (4.5)	28 (7.0)	26 (5.9)
Total Responses*	421	398	437

*The counts and percentages are based on the top 5 handwriting features that were intentionally changed.

Research Question 2: How many handwriting features do writers attempt to change when disguising their handwriting?

Participants reported that their intention was to change one to three handwriting features. For this reason, three categories for number of changes were created for each scenario: one, two, and three features changed. Table 4 shows the total number of intended changes made by the study participants. For scenario 1, 36.4% of participants intended to alter one handwriting feature, 39% intended to change two features, and 24.7% intended to make changes to three features. A similar pattern emerged for scenario 2 where 39.9% made one change, 39.3% made two changes, and 20.8% made three changes. For scenario 3, 40.6% of the participants altered one feature, 43.2% altered two, and 16.2% altered three features.

Table 4. Number of handwriting features changed by scenario

		Number of Changes			
		1	**2**	**3**	**Total Responses**
Frequency Share		**N (%)**	**N (%)**	**N (%)**	
Time (Scenario)	**#1**	112 (36.4)	120 (39.0)	76 (24.7)	308
	#2	123 (39.9)	121 (39.3)	64 (20.8)	308
	#3	125 (40.6)	133 (43.2)	50 (16.2)	308

A chi-square test of independence was used to assess the relationship between time (i.e., scenarios) and the number of handwriting features that the study participants attempted to change. As shown in Table 5, the chi-square test indicated that the relationship between the number of handwriting features changed and scenario, was not statistically significant, $\chi^2 = 7.004$, $p < 0.05$. Although these results were statistically insignificant, the trend was in the expected direction: fewer changes were made as the level of guardianship increased.

Table 5. Results of Chi-square Test for handwriting features changed

	Value	df	Asymp. Sig. (2-sided)[15]
Pearson Chi-Square	7.004	4	0.1357
Likelihood Ratio	7.071	4	0.1322
No. of Valid Cases	924		

Research Question 3: What are the unintentional (i.e., secondary) handwriting changes that occur as a direct result of the author's intentional changes?

As part of the coding process, participants' handwriting features were measured at baseline (i.e., normal handwriting without disguise), and also in each scenario condition in order to determine if (and how) features changed under the different scenarios. Changes from baseline that participants intended to make were recorded as intentional changes. All other deviations from the baseline condition were recorded as unintentional. Table 6 shows the handwriting features that were not changed, changed intentionally, and unintentionally changed by the study participants. When participants altered their signatures, the top five most common unintentional changes for scenario 1 were: lateral expansion (57%), the direction of the initial stroke (48%), the number of pen lifts (46%), the spacing of letters (45%), and connecting strokes (43%).

[15] The asymptotic test and the p-value both represent the probability for the test statistic. In SPSS, the Chi-square test result will return "Asymp. Sig (2-tailed)," "Exact (2-tailed)," and "Exact (1-tailed)." When the chi-square test was run, it returned the Asymp. Sig. (2-sided), which was used instead of the p-value.

Similarly, for scenario 2, lateral expansion (53%) was the most common unintentional change, followed by the number of pen lifts (44%), the spacing of letters (40%), the direction of the initial stroke (40%), and letter form of the last name (40%). For scenario 3, lateral expansion (30%), letter form of the last name (28%), the number of pen lifts (24%), the direction of the initial stroke (23%), and letter form of the first name (22%) were the most common unintentional changes. Additionally, when letter form of the first and last name were combined into a single letter form category, this handwriting feature became the most prominent unintentional change at 74% for scenario 1, 75% for scenario 2, and 50% for scenario 3.

Table 6. Counts of Handwriting features not changed, intentionally changed, and unintentionally changed across each scenario

Variable	N	Scenario #1			Scenario #2			Scenario #3		
		No Change	Int	Unint	No Change	Int	Unint	No Change	Int	Unint
Lat Expansion	308	131 (43%)	0 (0%)	177 (57%)	146 (47%)	0 (0%)	162 (53%)	217 (70%)	0 (0%)	91 (30%)
Instroke_Dir	308	159 (52%)	1 (0.3%)	148 (48%)	182 (59%)	4 (1%)	122 (40%)	237 (77%)	0 (0%)	71 (23%)
Pen_Lifts	308	164 (53%)	1 (0.3%)	143 (46%)	174 (56%)	0 (0%)	134 (44%)	232 (75%)	1 (0.3%)	75 (24%)
Spacing_ Letters	308	152 (49%)	17 (6%)	139 (45%)	174 (56%)	10 (3%)	124 (40%)	238 (77%)	17 (6%)	53 (17%)
Connecting Strokes	308	175 (57%)	1 (0.3%)	132 (43%)	196 (64%)	2 (1%)	110 (36%)	261 (85%)	1 (0.3%)	46 (15%)
Tstroke_Dir	308	171 (56%)	9 (3%)	128 (42%)	194 (63%)	8 (3%)	106 (34%)	240 (78%)	12 (4%)	56 (18%)
Letter Form Last	308	23 (7%)	168 (55%)	117 (38%)	43 (14%)	142 (46%)	123 (40%)	106 (34%)	117 (38%)	85 (28%)
Line Quality	308	189 (61%)	3 (1%)	116 (38%)	189 (61%)	4 (1%)	115 (37%)	257 (83%)	5 (2%)	46 (15%)
Letter Form First	308	35 (11%)	163 (53%)	110 (36%)	62 (20%)	137 (44%)	109 (35%)	141 (46%)	99 (32%)	68 (22%)
Size Absolute	308	151 (49%)	47 (15%)	110 (36%)	157 (51%)	51 (17%)	100 (32%)	218 (71%)	32 (10%)	58 (19%)
Legible Sig	308	111 (36%)	101 (33%)	96 (31%)	139 (45%)	82 (27%)	87 (28%)	211 (69%)	51 (17%)	46 (15%)
Slant	308	209 (68%)	9 (3%)	90 (29%)	233 (76%)	7 (2%)	68 (22%)	278 (90%)	5 (2%)	25 (8%)

Table 6 (cont'd)

Tstroke_End	308	222 (72%)	6 (2%)	80 (26%)	228 (74%)	2 (1%)	78 (25%)	264 (86%)	3 (1%)	41 (13%)
t-bar_Form	308	241 (78%)	0 (0%)	67 (22%)	244 (79%)	0 (0%)	64 (21%)	270 (88%)	0 (0%)	38 (12%)
Pun_i/j-dot Form	308	233 (76%)	8 (3%)	67 (22%)	248 (81%)	9 (3%)	51 (17%)	264 (86%)	9 (3%)	35 (11%)
Pun_i/j-dot Loc	308	235 (76%)	7 (2%)	66 (21%)	255 (83%)	7 (2%)	46 (15%)	266 (86%)	6 (2%)	36 (12%)
Pressure	308	244 (79%)	2 (1%)	62 (20%)	241 (78%)	7 (2%)	60 (19%)	275 (89%)	3 (1%)	30 (10%)
Align_Spec 2	308	240 (78%)	1 (0.3%)	67 (22%)	269 (87%)	1 (0.3%)	38 (12%)	287 (93%)	5 (2%)	16 (5%)
t-bar_Loc	308	255 (83%)	0 (0%)	53 (17%)	267 (87%)	0 (0%)	41 (13%)	279 (91%)	0 (0%)	29 (9%)
Align_Spec 1	308	273 (89%)	0 (0%)	35 (11%)	272 (88%)	1 (0.3%)	35 (11%)	296 (96%)	2 (1%)	10 (3%)
Order	308	272 (88%)	2 (1%)	34 (11%)	283 (92%)	1 (0.3%)	24 (8%)	288 (94%)	0 (0%)	20 (6%)
Style of Allograph	308	270 (88%)	18 (6%)	20 (6%)	263 (85%)	15 (5%)	30 (10%)	293 (95%)	5 (2%)	10 (3%)
Pun_period	308	286 (93%)	2 (1%)	20 (6%)	293 (95%)	2 (1%)	13 (4%)	294 (95%)	2 (1%)	12 (4%)
Spelling	308	237 (77%)	56 (18%)	15 (5%)	250 (81%)	44 (14%)	14 (5%)	262 (85%)	36 (12%)	10 (3%)
Hiatuses	308	294 (95%)	0 (0%)	14 (5%)	293 (95%)	0 (0%)	15 (5%)	300 (97%)	0 (0%)	8 (3%)
Abbreviation	308	273 (89%)	24 (8%)	11 (3%)	282 (91%)	18 (6%)	8 (3%)	290 (94%)	13 (4%)	5 (2%)
Embellish	308	290 (94%)	9 (3%)	9 (3%)	285 (93%)	10 (3%)	13 (4%)	294 (95%)	7 (2%)	7 (2%)
Instroke_ Start	308	298 (97%)	0 (0%)	10 (3%)	300 (97%)	0 (0%)	8 (3%)	305 (99%)	0 (0%)	3 (1%)
Hand	308	299 (97%)	9 (3%)	0 (0%)	305 (99%)	3 (1%)	0 (0%)	303 (98%)	5 (2%)	0 (0%)

* Note: percentages may not sum to 100 due to rounding.
**See Appendix A for handwriting variable definitions.

In addition to the information presented above, when the total number of unintentional changes for all of the handwriting features were summarized (Table 7), there was a noticeable drop in the number of unintentional changes in scenario 3. In fact, the total number of unintentional changes between scenario 1 and scenario 3 dropped by more than 50 percent. As

shown in Table 7, this decreasing pattern was consistent with the total number of intentional changes. As the number of intentional changes decreased, the number of unintentional changes also decreased. Additionally, when the total numbers of changes across the scenarios were compared, there were three times as many unintentional changes as there were intentional changes. However, when the total numbers of changes in each scenario were compared, the results illustrated that for scenarios 1 and 2, every intended change resulted in three unintended changes, but for scenario 3, every intentional change resulted in two unintentional changes.

Table 7. Summary of handwriting features changed by scenario

	Scenario 1	**Scenario 2**	**Scenario 3**	**Total Changes**
	N (%)	**N (%)**	**N (%)**	
Number of Intentional Changes	664 (40)	567 (34)	436 (26)	1,667
Number of Unintentional Changes	2,136 (42)	1,898 (38)	1,030 (20)	5,064

Exploratory Factor Analysis

First, a factor analysis was completed on the baseline condition (the condition under which the study participants naturally signed their name without a disguise). This information identified the handwriting features that clustered together under normal conditions. Second, the guardianship condition (the condition under which the study participants intentionally altered their signatures) was analyzed. This information identified the handwriting features that clustered together when the signatures were intentionally changed. Finally, the results for the baseline condition were compared to the results for the guardianship condition. It was determined that five factors gave the most interpretable solution. Results of the orthogonal rotation of the baseline condition solution are shown in Table 8.

Table 8. Orthogonally rotated component loadings for the baseline condition[1]

	Component				
Variable*	1	2	3	4	5
Letter Form_Last	0.941				
Letter Form_First	0.941				
Spacing_Letters	0.788				
Style of Allograph	0.427				
Slant	0.414				
Pun_i/j-dot Form		0.816			
Pun_i/j-dot Loc		0.805			
Pen Lifts		0.607			
Legible Sig		-0.427			
Tstroke_Dir					
Tstroke_End					
Size_Absolute					
t-bar_Loc			0.918		
t-bar_Form			0.895		
Pun_period				-0.639	
Order				0.614	
Connect Strokes				0.481	
Hand				-0.475	
Spelling					
Instroke_Start					
Align_Spec1					0.709
Align_Spec2					0.605
Line Quality					-0.535
Instroke_Dir					
Embell					
Pressure					
Abreviations					

1. Loading >= .40

*See Appendix A for variable identifications.

The Five Topic Factors

When loadings less than 0.40 were excluded, the analysis yielded a five-factor solution. Five variables were loaded onto Factor 1, which explained almost 11% of the variance. All five of these variables related to handwriting features that gave the writing a certain appearance,

including style of allograph, letter form, spacing, and slant. This factor was labeled "writing style." Four variables were loaded onto Factor 2, which was related to elements of execution (i.e., the less obvious, more subtle elements of writing), which were related to pen lifts, legibility, and i-dot form and location. This factor was labeled “writing execution.” The two items that loaded onto Factor 3 related to t-bar form and location. This factor was labeled “t-bar.” The four items that were loaded onto Factor 4 related to period marks, order of name, connecting strokes, and writing hand. This factor was labeled “writing structure.” Finally, the three items that were loaded onto Factor 5 related to alignment and line quality. This factor was labeled "writing fluidity." Overall, 39.9% of the variance in the baseline condition was explained by these five factors and can be seen in Table 9.

Table 9. Total variance explained for the baseline

	Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %
1	2.930	10.851	10.851
2	2.361	8.745	19.596
3	1.945	7.204	26.801
4	1.825	6.760	33.561
5	1.703	6.306	39.867

A subsequent factor analysis was performed on the combined guardianship condition[16], and the results were compared to the baseline condition. This comparison identified the difference in loadings between the participants’ normal handwriting and their disguised handwriting. Results of the rotation of the guardianship condition solution are shown in Table 10.

[16] The procedure used to complete the factor analysis for the baseline condition was the same procedure used for the combined guardianship condition.

Table 10. Orthogonally rotated component loadings for the guardianship condition[1]

	Component				
Variable*	1	2	3	4	5
LetterForm_First	0.761				
LetterForm_Last	0.731				
Spacing_Letters	0.628				
Size_Absolute	0.5				
Spelling					
StyleofAllograph					
Pun_ijdotForm		0.844			
Pun_ijdotLoc		0.835			
PenLifts		.591			
tbar_Form			0.899		
tbar_Loc			0.889		
Tstroke_End					
Order				0.54	
Instroke_Start				0.497	
Pun_period				-0.489	
Abreviations				-0.434	
ConnectStrokes					
Instroke_Dir					
Embell					
LineQuality					-0.598
Hand					0.456
Tstroke_Dir					0.435
Slant					0.424
LegibleSig					
Align_Spec2					
Align_Spec1					
Pressure					

1. Loading >= .40

*See Appendix A for variable identifications.

For the combined guardianship condition, there was a slight decrease in the overall explained variability, indicating that the factor model did not fit the data as well as the baseline. As seen in Table 11, the five factors accounted for 37.9% of the total variation. Slight changes in individual factor variances were also observed.

Table 11. Total variance explained for the guardianship condition

	Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %
1	2.597	9.617	9.617
2	2.335	8.648	18.265
3	2.001	7.412	25.677
4	1.740	6.443	32.120
5	1.585	5.869	37.989

Table 12 illustrates the variables that were more strongly correlated remained grouped across the baseline and guardianship conditions, whereas the variables that were not as strongly correlated did not appear in the guardianship condition. For example, when Factor 1 from the baseline condition was compared to Factor 1 in the guardianship condition, the first three variables (LetterForm_Last, LetterForm_First, and Spacing_Letters) were consistent with the first three variables in the guardianship condition. However, the last two baseline variables for Factor 1 (Slant and Style of Allograph) dropped off Factor 1 for the guardianship condition. This could be the result of what is shown in Table 5, where the first three variables in Factor 1 had high correlation scores of .941, .941, and .788, indicating that they were strongly correlated. The last two variables had correlation scores of .427 and .414. These low correlation scores indicated that these variables were less related to the factor, and they explained less of the variation. Therefore, when the study participants started changing handwriting features under the guardianship condition, these weakly correlated variables dropped off the factor. Additionally, when study participants started changing different aspects of their signatures, some variables appeared on a factor in the guardianship condition that did not show up in the baseline condition. This is true for the variable "size." In general, when people sign their name normally, their handwriting size tends to be consistent (Huber & Headrick, 1999). Thus, the variable "size" did not appear in Factor 1 for the baseline condition, but it did come up in Factor 1 for the

guardianship condition. This finding suggested that when study participants began changing handwriting features related to letter form and spacing, they unintentionally altered the size of their writing.

Table 12 also shows that while pen lifts and i-dot form and location remained grouped across the baseline and guardianship condition in Factor 2, handwriting legibility dropped off the factor in the guardianship condition. This finding suggested that pen lifts and i-dots were features of handwriting that were more stable and difficult to change, and that legibility was weakly correlated with the other handwriting variables in Factor 2. Therefore, when study participants started to change their i-dot form and location, they had less control over handwriting legibility, which became less important in explaining the variation. The two variables in Factor 3, which were related to the t-bar (t-bar form and t-bar location), were strongly correlated across the baseline and guardianship conditions. However, Factors 4 and 5 contained variables that were more weakly correlated. In Factor 4, the variables “Pun_Period" and "Order" remained grouped across the baseline and guardianship conditions. However, the variables "ConnectStrokes" and "Hand" did not appear in the guardianship condition, suggesting that when study participants changed the order of their name, and they either added or removed a period, the connecting strokes and writing hand became less important in explaining the variation. Conversely, when study participants changed the order of their name and the punctuation period, then initial strokes and abbreviations became more important. In other words, when the order of the name and period marks were changed, the study participants unintentionally changed their initial strokes and abbreviations. Factor 5 revealed that when the variable "LineQuality" was changed by the study participants, the variables related to alignment (Alignment_Spec1, Alignment_Spec2)

became less important, and the variables "Hand," "TStroke_Dir," and "Slant" were unintentionally changed.

Table 12. Comparison of baseline and guardianship factor solutions

Factors	Baseline	Guardianship (Scenarios 1-3)
1	Letter Form_Last Letter Form_First Spacing **Style of Allograph** **Slant**	Letter Form_Last Letter Form_First Spacing **Size**
2	Punctuation i-dot/jdot Form Punctuation i-dot/jdot Location Pen Lifts **Legibility**	Punctuation i-dot/jdot Form Punctuation i-dot/jdot Location Pen Lifts
3	t-bar_Location t-bar_Form	t-bar_Location t-bar_Form
4	Puncuation_Period Order of name **Connecting Strokes** **Hand**	Order of name **Initial Stroke** Puncuation_Period **Abbreviations**
5	**Alignment_Spec 1** **Alignment_Spec 2** Line Quality	Line Quality **Hand** **Terminal Stroke_Direction** **Slant**

Research Question 4: How successful are writers in executing their intended disguise strategy?

Overall, study participants had a 61.8% success rate (the rate for each subject was based on the number of their attempted handwriting changes). As shown in Table 13, the success rate decreased as the level of guardianship increased. The participants' mean success rate was 73% for scenario 1, 70% for scenario 2, and 43% for scenario 3.

Table 13. Table of success rates and 95% confidence intervals for each scenario

Scenario	Number	Mean	Lower 95%	Upper 95%
#1	308	73.1%	69.0%	77.2%
#2	308	69.6%	65.3%	73.9%
#3	308	42.9%	38.5%	47.3%

Table 14 illustrates the difference between scenario 1 and scenario 3 was significant ($p <$ 0.001), as was the difference between scenario 2 and scenario 3 ($p < 0.001$). However, the difference between scenario 1 and scenario 2 was not significant. These findings suggested that the study participants may have considered scenario 1 and scenario 2 to be similar, whereas scenario 3 appeared to disrupt the concentration participants needed in order to achieve their intended disguise strategy. This finding was consistent with the pattern observed in Table 6, where the intentional and unintentional changes in the participants' signature decreased by more than 50 percent from scenario 1 to scenario 3, whereas the difference between scenario 1 and scenario 2 was approximately 15 percent.

Table 14. Table of pairwise comparisons with 95% confidence intervals for each scenario

Scenario	- Scenario	Difference	Lower CL	Upper CL	p-Value*
#1	**#3**	30.2%	23.0%	37.4%	<.0001**
#2	**#3**	26.7%	19.5%	33.9%	<.0001**
#1	**#2**	3.5%	-3.7%	10.7%	0.4871

***** p-value from Tukey-Kramer's multiple comparison test
** $p < 0.0001$

Research Questions 5 and 6: Does the writer's disguise strategy change depending on the level of guardianship? If yes, how does it change?

The chi-square test result that appears in Table 15 showed no significant difference in disguise strategy across the three scenarios, $\chi^2 = 39.9778$, p <0 .05.

Table 15. Results of the chi-square test for assessing the relationship between guardianship and disguise strategies used

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	39.9778	4	0.5601
Likelihood Ratio	43.2769	4	0.4166
No. of Valid Cases	1678		

The additional chi-square test of independence (Table 16) used to assess the relationship between the level of guardianship and the top five handwriting features (Table 3) altered by the study participants showed no relationship (i.e., no change in distribution of the features that were changed based on the level of guardianship) $\chi^2 = 4.9421$, $p < 0.05$.[17]

Table 16. Results of chi-square test for assessing the relationship between guardianship and the top five disguise strategies used

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.9421	8	0.7637
Likelihood Ratio	5.0098	8	0.7565
No. of Valid Cases	1256		

Research Question 7: What is the writer's thought-process when choosing a specific disguise strategy?

As shown in Table 17, the scenarios had an effect on the study participants' thought-processes when choosing a disguise strategy. Under the lowest level of guardianship (scenario 1), 85.1% of the study participants claimed to make major changes to their signatures. Conversely, under the highest level of guardianship (scenario 3), only 2.6% of participants reported making major changes to their signatures, and 93.2% claimed to make only one or two minor changes to their signatures. Under scenario 2, 67.5% of the study participants tried to keep

[17] Separate chi-square tests were completed of scenario 3 compared to scenario 2, and scenario 3 compared to scenario 1. This supplemental analysis was first completed for all of the handwriting features, and then again for the top five handwriting features. The results of these chi-square tests revealed that there were no significant changes between these scenarios.

their signatures similar to their original signatures, whereas 17.5% chose to make major changes. Overall, a small number of participants indicated that the scenarios had no influence on their disguise strategy. For instance, only 1.3% of all participants stated that the scenario with the highest level of guardianship had no influence on their disguise strategy. Consequently, even when the participants were aware that their signatures would not be compared, the scenario had an effect on their decision-making.

Table 17. Ways in which the scenarios influenced the participants' disguise strategy

Frequency Share		**No Influence**	**Only 1 or 2 Minor Changes**	**Kept Similar**	**Major Changes**	Total Responses
Time (Scenario)	**#1**	27 (8.8%)	16 (5.2%)	3 (1.0%)	262 (85.1%)	308
Time (Scenario)	**#2**	17 (5.5%)	29 (9.4%)	208 (67.5%)	54 (17.5%)	308
Time (Scenario)	**#3**	4 (1.3%)	286 (93.2%)	9 (2.9%)	8 (2.6%)	307

It was hypothesized that as the level of guardianship increased, the participants' disguise strategy would be less prominent. Supporting the trend observed in Table 17, which shows that participants changed their disguise strategy based on the level of guardianship, the chi-square test result (Table 18) was significant, $\chi^2 = 1147.48$, $p < 0.0001$.

Table 18. Chi-square test for how participants were influenced by the scenarios

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1147.48	6	0.000*
Likelihood Ratio	1149.38	6	0.000*
No. of Valid Cases	923		

*p < 0.0001

Research Question 8: Why do writers choose a specific disguise strategy?

To understand why participants selected a particular disguise strategy, a frequency distribution table was created. The results reported in Table 19 show that the participants devised

a disguise strategy based on the level of guardianship. Under the lowest level of guardianship, 88.3% of the study participants developed a disguise strategy based on the premise that the guardian would not evaluate or compare their signature to a known handwriting sample. Therefore, they could make any change without fear of being caught. In contrast, under the highest level of guardianship, 87% of participants devised a disguise strategy out of fear of being caught. Similarly, 8.5% were careful when disguising their signature so that if the guardian questioned them, they could explain the difference between their disguised and known signatures. However, under scenario 2, there were two competing reasons for choosing a particular disguise strategy. On one side, 37.3% of participants felt that if the guardian evaluated their signature, he or she would not be very thorough. This made participants feel as though they could make any change and still get their signature past the guardian. Conversely, 40.6% of participants were careful in devising their disguise just in case the guardian evaluated their signatures. The idea that the guardian could evaluate their signatures was enough of a reason to make them pause and develop a disguise strategy that they felt they could explain if asked.

Table 19. Influence that the scenarios had on the participants' disguise strategy[18]

Frequency Share	**No Influence**	**No Comparison**	**Not Thorough**	**Careful**	**Feared Being Caught**	Total Responses

[18] Part II of the survey questionnaire consisted of six short-answer open-ended questions; two for each of the three study scenarios. These questions allowed participants to identify and describe the handwriting changes that they made when asked to disguise their signature, and explain why they chose a specific disguise strategy. The answers to these open-ended questions were analyzed and coded as suggested by Creswell (2007). The participants' answers to the questions were segmented and categorized based on common themes. After completing the coding stage, five main categories were created: (1) the scenario did not influence the participants' disguise strategy (no influence), (2) the participants knew that the guardian would not evaluate their signature, thus they could do whatever they wanted and get away with it (no comparison), (3) if the guardian evaluated the signature, he/she would not be thorough (not thorough), (4) the participants wanted to be careful in case the guardian evaluated their signature (careful), and (5) the participants were concerned about being caught (feared being caught).

Table 19 (cont'd)

Time (Scenario)	**#1**	27 (8.8%)	272 (88.3%)	2 (0.6%)	4 (1.3%)	3 (1.0%)	308
Time (Scenario)	**#2**	14 (4.5%)	7 (2.3%)	115 (37.3%)	125 (40.6%)	47 (15.3%)	308
Time (Scenario)	**#3**	3 (1.0%)	1 (0.3%)	10 (3.3%)	26 (8.5%)	267 (87.0%)	307

The chi-square test assessing the relationship between the level of guardianship and the participants' reasons (i.e., why) for choosing a particular disguise strategy was significant, χ^2 = 1260.11, $p < 0.0001$ (Table 20). This finding supported the trend observed in Table 20. As the level of guardianship increased, the participants' fear of being caught resulted in a less prominent disguise strategy.

Table 20. Chi-square test for why participants were influenced by the scenario

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1260.11	8	0.000*
Likelihood Ratio	1309.62	8	0.000*
No. of Valid Cases	923		

*p < 0.0001

CHAPTER 6: DISCUSSION AND CONCLUSION

Environmental criminologists argue that because crime will persist rather than be eliminated from society, prevention is the best approach (Clarke, 1980; Eck & Weisburd, 1995; Felson & Boba, 2010). The tenets of routine activity theory and situational crime prevention are all about focusing on specific types of crime. In regard to this study, signature forgery is a crime that can be broken down into five different types: (1) simple, (2) simulation, (3) tracing, (4) cut-and-paste, and (5) auto-forgery. Each type of signature forgery should be studied independently as each will have different patterns. The same is true when studying guardianship. There are different kinds of guardians and their effects on the offender may vary depending on the type of crime, where it takes place, and the capability (real or perceived) of the guardian. Since a focused approach on crime prevention requires a comprehensive understanding of the specific type of crime being studied, it is crucial to understand both the technical aspects of the particular criminal act and the impact that a specific kind of guardian has on the crime problem.

Part I – Disguised Handwriting (Research Questions 1 – 4)

Although disguised handwriting is regularly encountered in the field of forensic document examination, distinguishing disguise from different authorship remains a problem area for many investigators (Bird et al., 2010; Bird et al., 2012), which may be partly due to a serious lack of empirical work on this subject area (NRC/NAS, 2009). Two of the fundamental principles that underlie handwriting identification are: (1) no two writers share the same combination of handwriting characteristics, and (2) an individual's normal writing always has some degree of natural variation which prevents the writer from signing his or her name the exact same way twice. Although these principles are lacking in empirical support (NRC/NAS, 2009), currently they are the foundation that the field of questioned document examination is

built upon. It is beyond the scope of this study to address the need for such support. Thus, the methodology used to evaluate the signatures in this study was based on standards (ASTM International, 2007) developed by the questioned document examination community.

Primary Disguise Strategies

The findings from the analysis used to identify the primary disguise strategies revealed that although there were 21 handwriting features that were purposely changed by study participants, only a few of these handwriting features were frequently changed. Letter form was the most common handwriting feature altered by the study participants. This finding was consistent with previous research that also identified letter form as being the most frequently altered handwriting feature (Alford, 1970; Harris, 1953; Herkt, 1986; Konstantinidis, 1987; Michel, 1978; Mohammed, 1993). The four other most frequently altered handwriting features identified in this study included legibility, size, spelling[19], and spacing. This finding was different from previous research studies that did not report legibility and spelling as frequently used disguise strategies (Herkt, 1986; Konstantinidis, 1987; Michel, 1978; Mohammed, 1993). Although previous research has reported signature size and spacing as commonly used disguise strategies (Herkt, 1986; Michel, 1978; Mohammed, 1993), neither of these two handwriting features were identified as one of the top five handwriting features altered in these studies. The reason for the inconsistent findings may be due to differences in study design and the interpretation of the results. In this study, signature forgery was investigated exclusively, there was a large sample size, and a survey questionnaire that solicited information about the participants' intentional changes was incorporated. Previous studies, however, investigated disguised handwriting in signatures and handwritten notes (Harris, 1953; Konstantinidis, 1987),

[19] Spelling referred to the way the letters were grouped to form a word. A list of definitions for the handwriting variables used in this study can be found in Appendix G.

and these earlier studies often utilized small sample sizes (e.g., Konstantinidis, 1987) with study populations that posed a variety of threats to validity. For example, one study had a sample population composed entirely of police officers (Herkt, 1986). Considering that some police officers receive training in forgery detection and investigate forgery crimes, their approach to signature disguise may be much different than the strategy used by a novice.

Additionally, the authors of these previous studies did not ask their participants to report the intentional changes they made. Instead, the researchers collected the disguised signatures and handwriting, and then interpreted the results. Therefore, they did not differentiate between the intended and unintended changes. Consequently, the authors may have interpreted some unintended changes as being intentionally made by the study subjects. For example, slant was reported as one of the most common disguise strategies (Harris, 1953; Herkt, 1986; Konstantinidis, 1987; Michel, 1978; Mohammed, 1993). However, slant may be an unintentional change that was wrongly interpreted as purposeful and categorized as a common disguise technique.

Unintended Handwriting Changes

Previous research on disguised handwriting has not explored or identified the unintentional changes that occur as a direct result of the author's intentional changes. However, this information is important to investigators when they evaluate a questioned writing sample. Some of the differences that were noted between an authentic and questioned body of writing may have been misinterpreted as a sign of a simulated forgery, when in fact it may have been an unintended change that resulted from an intentional alteration made by the author when disguising his or her signature. For example, when writers intentionally alter letter forms to make their signatures appear differently, they may also unintentionally alter other handwriting features,

such as the speed of the writing. When a person consciously alters his handwriting, he may have to slow down the speed of his writing to execute his intended change. As a result of the slower writing speed, the writing line may show signs of tremor (i.e., an unsteady wavering stroke produced by a vibratory motion of the writing hand), which is a typical sign of a simulated forgery (Osborn, 1929). Considering that examiners have a difficult time differentiating a disguised writing from a simulated forgery (Bird et al., 2010; Bird et al., 2012), the consequence of this for the investigator and the victims involved is considerable. Osborn (1929) and Hilton (1982), two of the leading authorities of questioned document examination in North America, and other experts have asserted that if there is at least one significant[20] unexplainable difference, it can be inferred that the authors of the questioned and the known writings are different. Therefore, a disguised signature will contain at least one difference that may be considered significant by the investigator and wrongly identified as a simulated forgery. In fact, it seems likely that this misidentification problem occurs quite often.

A list of the unintentional handwriting changes was developed for each scenario. Lateral expansion was the most frequently occurring unintentional change across all three scenarios. Other commonly occurring unintentional changes included initial strokes, pen lifts, the spacing of letters, and letter form. Although the factor analysis provided a limited amount of additional information, it revealed that when participants began changing handwriting features related to letter form and spacing, they unintentionally changed the size of the writing. Letter form,

[20] *Significant* is a subjective and controversial term used in the field of questioned document examination. What may be considered a significant difference by one examiner may be classified as insignificant by another examiner. When forensic document examiners evaluate a signature for authenticity they rely upon their education, training, and experience to make a subjective determination regarding the similarities and differences they identify. If a difference is considered to be significant, then the signature in question is classified as a forgery. If the differences are considered to be insignificant, then they are attributed to the natural variation of the writer and the signature is authenticated.

spacing, and size are handwriting features that, when combined, give the writing a certain "look." Therefore, if a writer wanted to make his or her signature "look" different by changing the letter form or spacing, then the size of the writing would most likely increase or decrease due to the forced change of the other two closely related features.

The results of the analysis also revealed that when participants changed their i-dot form and location, they had less control over the legibility of the writing. Considering that i-dot form and location was a rare disguise strategy, this finding probably had more to do with the legibility of the writing. If the author altered the legibility of his or her signature, then it makes sense that the i-dot form and location would change. By making the writing neater, the author was more likely to reduce the speed of the writing, which resulted in a more carefully placed i-dot above the i-stem. Conversely, when the author made the writing messier, he or she most likely increased the speed of the writing, which made the location and form of the i-dot more variable. Additionally, when the order of the name and period marks were altered, the initial strokes and abbreviations were unintentionally changed. This finding was not surprising given that different letters have initial strokes that begin in different locations, and when the order of the name was altered, the starting strokes changed by necessity. In other words, letters have initial strokes that begin in different locations. Therefore, by changing the order of the name, the initial strokes also changed. Moreover, when an author abbreviated his or her name, a period may have been added. Similarly, if the writer removed an abbreviation by deleting it or spelling out the full name, then the period would have been removed. Additionally, when the line quality of the writing changed, variables related to alignment, the direction of the terminal stroke, and the slant unintentionally changed. Line quality has to do with the smoothness and rhythm of the writing line. Therefore, when a writer naturally produces a signature, there is a fluid "look" to it. Writing

with good line quality has a regular slant with letters that are arranged in a consistent way. However, if the line quality of the writing is reduced, then the letters and slant become inconsistent, giving the writing a clumsy "look." Thus, changes in alignment and slant are closely related to line quality.

It is important to consider that there were a number of limitations with the Exploratory Factor Analysis. First, there was a question as to the factorability of the data. While it was noted that the KMO = .591 was 'acceptable' according to Tabachnick and Fidell (2001), other guidelines, such as those identified by Kaiser (1974), would determine this to be below average, and therefore not adequately related for factor analysis. Thus, it was difficult to determine whether the observed changes between baseline and guardian conditions reflected a pattern of behavioral changes or variability that may have reflected the modest factorability of the data.

Number of Handwriting Changes Made by the Study Participants

Study participants were given the freedom to incorporate as many changes to their signatures as they wanted to make. Interestingly, the total number of intended changes, as reported by the study participants, ranged from 1 to 3. This finding suggested that as the number of intended changes increased, it became more difficult for study participants to execute their disguise strategy. Because handwriting is habit-formed (Caligiuri & Mohammed, 2012), when an individual intends to alter his handwriting, he must do so in a way that allows him to maintain some pictorial similarity[21] to his normal signature. However, the altered signature must be dissimilar enough that at a later point in time, he can claim that the signature is not his. Therefore, if a writer wanted to devise a successful disguise, it seems like the best strategy would

[21] The handwriting features that give a signature a certain "look" (e.g., letter form, slant, size, spacing) are often targeted by forgers to make their fake signature "look like" the authentic signature. Pictorial similarity is the term used to describe two signatures that are visually similar.

be one where fewer changes were made to the handwriting. Indeed, if a writer incorporated too many changes at one time, then he risked creating a grotesque signature that would be more difficult to get past a guardian. In other words, as the number of handwriting changes incorporated into the disguise strategy increased, the likelihood of success decreased. Although the chi-square results were statistically insignificant, the trend that fewer handwriting changes were made as the level of guardianship increased supported the idea that fewer changes were easier to execute while maintaining a pictorial similarity to the natural signature. This was important if the participants' goal was to get the disguised signature past the guardian. Conversely, under the lowest level of guardianship, an increased number of changes may have resulted in a more grotesque-looking signature that would have been easier to deny later.

Another interesting aspect of this finding was that even though the number of changes decreased as the level of guardianship increased, one change could be much more effective than three or more. For example, under scenario 1, a participant could make one change that would make the signature unidentifiable. As shown below, the writer made one change to his normal signature (Figure 5a), which resulted in a straight line (Figure 5b). Although there was only one change, the change could be classified as a forgery by a non-certified expert[22].

Figure 5a. Naturally written signature

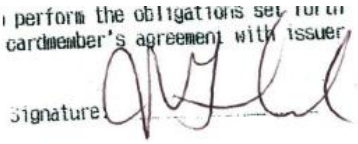
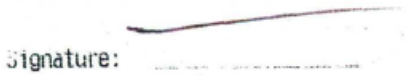


Figure 5b. Altered signature



[22] The field of questioned document examination is one of the most fragmented areas of forensic science. Certified experts would most likely reach an inconclusive opinion regarding the signature shown in Figure 5b. However, non-certified forensic document examiners and some law enforcement professionals might reach a different conclusion. More specifically, the signature may be classified as a forgery and the writer of this disguise eliminated as authoring the signature.

The straight line disguise strategy illustrated above was used under scenario 1, but it was not employed under scenario 3. When a participant made a change under scenario 3, in which a guardian was present, it was less prominent. For example, Figure 6a was the writer's normal signature under scenario 3, and Figure 6b was the author's altered signature under scenario 3. The writer's disguise strategy was the addition of a line under his last name. In this case, it would not be difficult to identify the author of the signature.

Figure 6a. Natural signature created for scenario 3

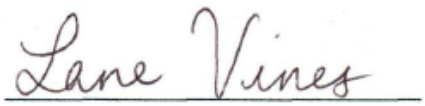
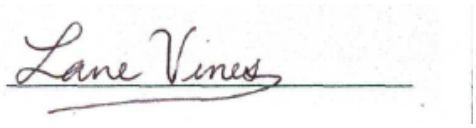


Figure 6b. Altered signature created for scenario 3



Considering these findings, it appeared as though the study participants had a couple of constraints. First, because writing is habit formed, they were cognitively unable to concentrate on more than three changes at a time. If they tried to change too many handwriting features at the same time, then they risked failing their disguise attempt. Second, although one change could be much more effective than three, the kind of change employed was determined by the level of guardianship. As illustrated in Figures 5a and 5b, one major change was only viable when a guardian was absent. Therefore, more changes did not necessarily equal a more effective disguise strategy.

Finally, the number of intentional changes was limited to 1 – 3, but the number of unintentional changes was much higher. For example, the author of the signature in Figure 5b made one intentional change that resulted in numerous unintentional changes such as letter form, size, initial strokes, terminal strokes, slant, and alignment. Although this example is a unique case because most study participants did not employ this strategy when disguising their signatures, it did show that an intentional change resulted in several unintentional changes.

The fact that one change generally resulted in two or three times as many unintentional changes illuminated the problems examiners encounter when authenticating a signature. Therefore, examiners should consider disguise when evaluating all questioned signatures, and use caution when weighing observed differences based on what is commonly believed to be the tell-tale signs of forgery. Indeed, these forgery indicators may simply be the unintentional changes that resulted from a specific disguise strategy.

Participants' Success in Executing Their Intended Disguise Strategies

Although the study participants intended to change their signatures in a variety of ways, they were not always successful in executing their disguise. Overall, 62% of the study participants successfully executed their disguise strategies. Interestingly, the participants' success rate decreased as the level of guardianship increased. However, when evaluating the differences in success rates across scenarios, a pattern emerged. The difference between scenario 1 and 3 and scenario 2 and 3 was significant, but the difference between scenario 1 and 2 was not. This suggested that the study participants may have viewed the guardianship under scenario 1 and scenario 2 in a similar way. This helped explain why the success rates for scenarios 1 and 2 were similar, but different from scenario 3. Indeed, under the highest level of guardianship, the participants' success rate was only 43%. Perhaps the higher level of guardianship disrupted the concentration participants needed in order to achieve their intended disguise strategy.

Another possible explanation for the similar success rates between scenarios 1 and 2 was that under these scenarios, the participants' intended changes were more pronounced than under scenario 3, which resulted in a higher success rate. For example, under scenarios 1 and 2, the writer may have intended to change the writing size by making it larger. Because of the

decreased level of guardianship, the writer may have subconsciously made the writing much larger than he would have under scenario 3. This makes sense when thinking about the effect that guardianship has on the writer. Not only did the number of changes decrease, but perhaps the quality of the intended changes also decreased as guardianship improved. Additionally, the overall success rate of 62% suggested that some participants may have thought that they executed their intended change when they had not. This finding was consistent with previous research that reported study participants failing to execute their intended disguise strategy (Harris, 1953; Konstantinidis, 1987). Habit may provide a good explanation as to why participants thought they made a change when they had not. Because a signature is habit formed, it is unlikely that a person could explain how he made his signature. In other words, when asked, most people would have a difficult time explaining how they sign their name. As a result, when a person intentionally alters his signature, he has to guess what is normal and then deviate from that. Of course, this is hard to do because of natural variation, which creates a range of normally occurring differences. However, if his attempted disguise strategy was more prominent, the chance of getting it right was improved. This is where guardianship really had an effect on the writer. Under the highest level of guardianship, the writer was more careful, and the chances of him creating a prominent change were less likely than when guardianship was absent. By altering a signature in a less prominent way, the writer increased his chance of making a change that fell within his range of natural variation.

Part II – Guardianship (Research Questions 5 – 8)

The Guardian's Effect on the Participants' Disguise Strategy

The participants' disguise strategy did not change depending on the level of guardianship. The reason for this may be due to the study participants' limited understanding of handwriting

identification, and all of the different aspects involved in the handwriting process. While certified experts are educated in all of the different handwriting features, most laypeople are not. Therefore, individuals who purposely changed their handwriting chose to focus on those handwriting features that gave the handwriting a certain "look" (Huber & Headrick, 1999). It is unlikely that a person who was not trained in handwriting identification would think to change such handwriting features as i-dot form and location, t-bar form and location, or initial and connecting strokes. Instead, letter form, legibility, size, and spacing are four handwriting features that when changed make the handwriting "look" different, and they were the handwriting features most frequently changed in this study. Thus, when participants altered their handwriting, they did not target different handwriting features based on the scenario. Instead, they modified the number of changes they made to the signature.

Participants' Thought-process Behind a Specific Disguise Strategy

Research questions 7 and 8 were used to explore the thought-process behind the participants' choice of disguise strategy, and tested how the level of guardianship influenced the participants' decision-making. The analysis revealed that the participants were influenced by the scenario. The seventh research question addressed how the participants were influenced by the level of guardianship, and the eighth research question addressed why the level of guardianship influenced their decision to use a specific disguise strategy. Under the lowest level of guardianship, participants knew that they could change whatever they wanted in their signature and get away with the disguise. Hence, most of the participants made major changes to their signatures. Some of these included the writer signing a completely different name or drawing a straight line (Appendix H). Although several participants viewed scenario 2 as having ineffective guardianship, many of them still wanted to be cautious in case the guardian did check their signature. As a result, a little over half of the participants kept their disguised signature similar to

their normal signature. This finding was interesting because it demonstrated how a guardian that may be viewed as being ineffective can still affect the behavior of the forger. Unlike scenarios 1 and 2, under the highest level of guardianship, the vast majority of participants only made one or two minor changes. These findings showed that when participants perceived the guardian as capable, they changed their strategy to ensure that the signature would be accepted by the guardian, while also leaving themselves with a point of difference to deny the signature at a later date. Of course, a large number of these minor changes fell within the writer's natural range of variation, resulting in a failed disguise strategy. As discussed above, forgery and document fraud crimes are different from the crimes that are generally studied by environmental criminologists. Unlike crimes of burglary and auto-theft where the offender does not have to interact with a guardian, in crimes of forgery the offender must interact with the guardian. A guardian can help deter forgery crime. However, a guardian will not deter all forgery crimes, but he or she can impact the manner in which the forgery is written, to the point where the disguise strategy fails. A failed disguise attempt is the next best thing to deterrence since it will ensure that evidence that can help solve the crime is left behind by the forger.

Research question 8 helped explain why the increased level of guardianship resulted in only minor changes to the handwriting. Under scenario 3, the study participants reported a fear of being caught as the primary reason for only making one or two minor changes. Under scenario 1, the study participants made what they considered to be major changes to their signature because they knew that no comparison would be made, which increased the likelihood of getting away with the crime. Scenario 2 was interesting in the sense that participants had two competing reasons for their disguise strategy. One group who perceived the guardian as being incapable reported that they could do anything to their signature because the guardian would not be very

thorough in their comparison of the signatures. These participants also stated that even if the guardian did question them about the differences, they felt confident they could talk their way out of the situation[23]. The other group stated that they wanted to be careful in case their signature was compared. As a result, they attempted to keep their signature similar to how they normally signed their name.

These findings suggested that the perceived level of guardianship was more important than the actual guardianship. If the participant perceived the guardian as being capable, and feared being caught, they made minor changes to their signature. However, if the participant perceived the guardian as being incapable, then they made, what they claimed to be, major changes to their signature. This finding supported Tilly's (2009) observation that guardian capability may be less important than guardianship credibility.

The results from this study suggested that having a guardian present in crimes related to forgery and document fraud was not enough to prevent many of the crimes. Even when a guardian was present, a third of the study participants made major changes to their signatures. Similarly, under scenario 3, the participants' disguise strategy was based on their perception of the guardian's capability. The guardian only had to be perceived as being capable, which created caution[24] in a majority of the participants, resulting in a considerable modification in their disguise strategy. This change ultimately resulted in two outcomes. First, many of the disguise attempts failed. Second, the successful disguise strategies resulted in only a few minor alterations

[23] These thoughts were drawn and paraphrased from Part II of the survey questionnaire where the study participants answered open ended questions about how and why the level of guardianship influenced their disguise strategy.

[24] Participants used phrases such as "I feared being caught" and "I was scared that I would get caught" to explain why they chose a certain disguise strategy under scenario 3.

that made a future identification highly probable.[25] Figure 7a is an example of the writer's natural signature. Under scenario 3, the writer successfully changed the ending stroke in his signature (Figure 7b). However, the alteration was minor and a certified expert would evaluate this signature and most likely conclude that the writer of the Figure 7a signature was the writer of the Figure 7b signature. Therefore, if the guardian was unable to prevent a crime from taking place, the results of this study illustrated that she could affect the forgers' behavior in a way that increased his chances of being identified after the crime had been completed, or the guardian could force a behavior that resulted in a failed attempt by the forger.

Figure 7a. Natural signature created for scenario 3

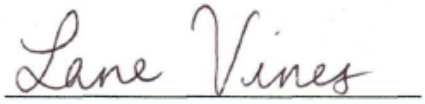
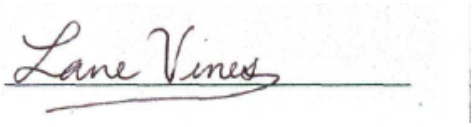


Figure 7b. Altered signature created for scenario 3



Limitations of Study

All research has limitations and this study was no exception. Due to the nature of this project and the research questions that were asked, particular attention was given to the study's internal validity. Therefore, in order to ensure that the change in the disguise strategy was produced solely by the level of guardianship and not by an extraneous factor, the data collection phase of this research took place in a controlled environment. Of course, by focusing on the study's internal validity, the generalizability of its findings were necessarily weakened (Shadish, Cook, & Campbell, 2002). However, this was considered to be an acceptable trade-off.

[25] When a certified handwriting expert evaluates a signature for authenticity, he compares the questioned writing to the known writing sample and notes all similarities and differences. If the questioned writing does not have any significant unexplainable differences, then the questioned signature is authenticated. In the current study, a participant's disguise strategy may have been successful, but when evaluated by a certified expert, the alterations may be categorized as insignificant due to natural variation. This would result in a positive identification.

The integration of new technology must also be considered. It has become common for retailers to use digital tablets to capture customers' signatures, which varies from ink-to-paper signatures in a variety of ways. For example, the writing position and the writing instruments used to sign digital tablets are different from those used to sign a piece of paper. This study did not explore how the study participants' behavior might have been affected by a digital tablet, or how their disguise strategy might have changed. Therefore, the findings can be applied to auto-forgery on paper, but not necessarily auto-forgery on tablets.

Each participant was given a limited amount of time to prepare for the handwriting exercise. Although the participants were initially "primed" to think like someone who wanted to disguise their handwriting, and were allowed to practice disguising their handwriting for a few minutes before executing their disguise strategy, it is possible that some of the participants might not have been fully committed to the exercise. In other words, their effort to disguise their handwriting may have been different if they had been in the real world. The participants in this study knew that they were in a controlled environment, and that it was an experiment with no consequences. As a result, they had a chance to be as daring as they wanted without worry of being caught and punished. Moreover, in a real world setting, forgers may spend several hours thinking about the disguise strategy they want to use; this was not possible in a controlled environment.

Finally, although the measures used and the coding scheme completed were reliable, there may be some questions regarding the coding of the handwriting data collected or the ability and interpretations of the coder. Due to resource limitations, a Board Certified Forensic Document Examiner completed all of the coding. Although the coding scheme used was based

on established standards (ASTM International, 2007), it was possible that other certified document examiners may have obtained different results.

Despite the concerns identified above, this was the first study that used a large sample size to investigate disguised signatures in a comprehensive way. Furthermore, it was the only research that investigated how an offender's perception of capable guardianship affected the disguise strategy used. The findings from this study can help scholars draw inferences from which more specific studies can be designed. For example, studies involving how manager-guardians interact with and affect the behavior of offenders can be developed. Additionally, the primary (intended) and secondary (unintended) handwriting changes that have been identified in this study can be used to further our knowledge of the differences between forgery versus disguise, and forgery versus simulation.

Directions for Future Research

Future research could focus on signature forgery and the guardianship aspect of routine activity theory.

Signature Forgery

It was beyond the scope of this study to test whether the disguise strategies used by the study participants would actually be accepted by a guardian or trick an expert into thinking that the disguised signature was not authored by them, but forged by someone else. Therefore, one direction for future research is to conduct a similar study to test the proficiency of handwriting experts and non-experts such as cashiers and bank tellers. Such a study could potentially be redesigned in the following way. First, a pool of study participants would be selected and then told to disguise their handwriting under conditions similar to the ones used in this study. Next, a group of people would be instructed to simulate the study participants' normal signatures. After

both of these steps were completed, the signatures would be assembled for the proficiency test which would consist of ten to fifteen normal signatures for the test takers to use as their comparison sample. Then a group of questioned signatures would be created from the disguised signatures, the signature simulations, and the writers' natural signatures. The experts, cashiers, and bank tellers would determine if the questioned signatures were authored by the known writer, disguised by the known writer, or simulated by somebody else. This kind of exercise would identify which disguise strategies were the most effective in deceiving the experts.

Another direction for future research relates to the importance of different handwriting features and the number of changes that are intentionally made to a signature. It is unknown what altered handwriting features are most likely to fool the experts when disguising a signature, and how many changes are necessary to convince handwriting experts that it is not a disguised signature. While it may seem that the more changes someone made to his/her signature, the more successful the disguise strategy would be, this might not be the case. For example, a single intended change can be a more successful disguise (able to get past the guardian and fool the experts into thinking it was not authored by the claimant) than a disguise strategy that incorporates three or four intentional changes (Figure 5a; b). Therefore, this aspect of signature disguise, relating to number and type of features, needs to be investigated further.

In this study, unintentional handwriting changes that occurred as a result of the writer's intentional changes were identified. However, because each writer created up to three changes to his or her signature, it was not possible to identify which intentional changes caused other handwriting features to unintentionally change. Future research may be able to identify the correlations between the intended and unintended handwriting changes by focusing on one change at a time. For example, participants could be asked to change a handwriting feature, such

as letter form. After making the intended change, the unintended change could be identified. Participants could then be asked to change another handwriting feature, such as size. This process could be repeated until the different handwriting features have been isolated and correlated to the unintended changes.

Another area in need of future research involves signatures on electronic devices. The use of digital tablets by retailers to capture customers' signatures is very common. However, the signature produced on a digital tablet is different in a variety of ways from an ink-to-paper signature. For example, the writing position and the writing instrument used to sign vary. Future research could investigate how individuals' disguise strategies might be affected when signing on a digital tablet, and how they might be different from the ones used on a paper document. Moreover, digital tablets provide additional information on handwriting features (e.g., speed) that cannot be accurately determined from a paper signature. Therefore, a study similar to this one, but using digital tablets, could be a contribution to the current literature on signature disguise.

Finally, further investigations on other types of forgery such as simple and simulation would provide valuable insight into the differences between disguised signatures (auto-forgery) and signatures created by someone else (simple and simulated forgeries). Perhaps, the handwriting features chosen by a person who is trying to simulate a signature to make it look authentic are the same features chosen by a disguiser to make the signature look different from the authentic. This kind of study would be helpful in understanding the different types of document forgeries that exist and the thought process followed by the individuals creating the forgeries.

Environment and Guardianship

Clarke (1997), Felson and Boba (2010), and other crime prevention scholars claimed that focusing on crime situations can reduce crime. In this study, auto-forgery was investigated. However, if a similar study looked separately at other types of forgery (simple, simulation, tracing, and cut-and-paste), different patterns could emerge. Thus, a future study could be conducted to explore how guardian(s) affect different kinds of forgers.

Other directions for future research include conducting observational studies of manager-guardians in their workplace to examine how they interact with customers and evaluate documents. For example, what forms of identification do manager-guardians request from customers, and how long do they spend evaluating them? Similarly, studies could be designed to investigate how different types of guardians (handler-guardians, manager-guardians, target-guardians) influence forgers' decision-making, and if their view of authority affects their guardian capability assessment. In other words, are positional authority figures such as manager-guardians viewed as being more capable than target-guardians (e.g., pedestrian, shopper, etc.)? These kinds of research questions may be answered through interviews and ethnographic studies.

Finally, an alternative approach to the present study could include an experiment within this design. Random assignment of one-third of the study participants to each one of the three scenarios could strengthen the experiment. Adding this kind of randomization to the research design would eliminate any potential biasing effects resulting from how the participants interpreted the handwriting disguise exercise in relation to the increasing levels of guardianship.

Policy Implications

Guardianship mattered in forgery and document fraud crimes. As the level of guardianship increased, the study participants' disguise strategies changed. In terms of policy

implications, this suggested that prevention should be focused on reducing opportunities for signature disguise, and encouraging those closest to the crime problem to become more active in increasing the risks for the offender. Clarke (1997) developed sixteen situational crime prevention techniques that could be used by practitioners to reduce criminal opportunities. Since 1997 the number of these preventative techniques has grown to twenty-five[26] (Cornish & Clarke, 2003; Pop Center, 2015), and are based on five main mechanisms: (1) increase the effort required to commit the crime, (2) increase the risks the offender must make to carry out the crime, (3) reduce the rewards obtained from the crime, (4) reduce provocations that may tempt offenders into criminal acts, and (5) remove excuses for the criminal offense. However, Clarke (2005) acknowledged that not all of the techniques are equally suitable for all crimes. Thus, understanding a specific crime problem will enable practitioners to employ the most effective preventative technique.

Based on the findings of this study[27], the most effective situational preventative techniques for forgery and document fraud crimes are those that increase risks. The following are some suggested actions that business owners and security professionals may take to prevent forgery and document fraud. First, people who alter their signature devise a disguise strategy based on their assessment of the guardian's capability. Therefore, business owners could place a sign on their entrance door that says something along the lines of, "our employees are trained in forgery detection," "we check every ID and signature," or "all forgers will be prosecuted." If the

[26] For a complete list of Clarke's classification of the 25 situational crime prevention techniques visit: http://www.popcenter.org/25techniques/.

[27] The possibility of getting caught was enough to impact the study participants' disguise strategies. Thus, situational crime prevention techniques that make offenders think they have a higher risk of getting caught are enough in preventing or altering a disguise strategy.

offender believes that her signature will be checked, and that the risk of getting caught is higher, then she will either abandon the forgery attempt or change the way her signature is disguised.

Another strategy would be to strengthen formal surveillance. For example, the business owner could employ loss prevention professionals who are visible and active around the checkout counters. These employees could actually be trained in forgery detection or they could act in a way that makes the customers believe that they are. In other words, the loss prevention staff could be seen checking IDs and signatures. This same effect could also be accomplished with the other store employees. The managers could have their cashiers take more time comparing signatures and checking IDs. Again, the important thing is to make the offender believe the guardians know what they are doing and that their risk of getting caught is higher.

Similarly, utilizing additional place managers and rewarding vigilance would improve surveillance and send a message to the public that the business is cracking down on forgery and document fraud crimes. The additional place managers could assist other store employees by checking IDs and signatures more thoroughly while not increasing the wait time for customers. Furthermore, rewarding store employees who report signatures that do not "look" right to store management could increase their interest in identifying forgeries.

Finally, under scenario 1, most of the study participants made major changes to their signatures. Therefore, restaurant owners could institute a policy that all signatures are to be compared and that the wait staff will not leave the customer’s table until the check has been signed. Another option would be to have the customers pay for their meal at a checkout counter. This would require the customer to sign the document in front of a guardian, and would allow other customers to observe the cashier checking signatures and IDs.

Conclusion

The current study expanded the existing knowledge on signature disguise in two ways. First, it identified the handwriting features that were intentionally altered by the study participants when disguising their signatures. Second, it identified the unintentional handwriting changes that resulted from the intentional changes. While some of the findings were consistent with previous research on disguised handwriting, other findings were not. For example, spelling was one of the most frequent handwriting changes made by the participants in this study, but it was not identified as a commonly occurring change in previous studies. The results also showed that participants were not always successful in executing their intended handwriting changes.

The guardianship concept was explored by examining the influence that manager-guardians have on individuals who must interact with a guardian in order to accomplish their crime. Considering the findings of this study, and how the guardians' role has been defined, it is clear that current definitions do not capture guardians and guardianship in a way that includes all types of crime. Forgery is a crime that often requires the offender and the guardian to interact. Moreover, considering the societal impact of forgery, it is clear that many of these crimes are not being prevented. Thus, in addition to preventing crime, the guardians' role should also include a behavior alteration component. In other words, if the guardian does not prevent the crime from occurring, then the guardian should alter the behavior of the offender in such a way that she can be identified after the crime has occurred.

The tenets of routine activity theory and situational crime prevention emphasize the importance of focusing on particular types of crime so that specific crime prevention strategies can be employed. Guardianship is one of the main concepts in routine activity theory, and one of the key elements in the criminal event model. This study has shown that guardianship can affect

how a forger disguises her handwriting. It appears that when the offender and guardian interact, the offender makes decisions on how best to carry out the crime based on his or her assessment of the guardian's capability and the risk of being caught. Therefore, in order to study the guardianship concept and apply it to different crime problems, the definition needs to be expanded to not only include crime deterrence, but to also include behavior alteration. As a result, the following definition of a capable guardian is proposed: a capable guardian can be defined as an individual(s) whose presence either prevents a crime from occurring or alters the undeterred offender's behavior in such a way that a useful form of evidence is left behind at the crime scene, which enables investigators to identify the offender at a later date. In other words, the guardian's primary task is to prevent the crime from taking place, and the secondary task is to alter the behavior of the undeterred offender. Further, this study has shown that by combining forensic science with social science, a specific crime problem, such as forgery, can be studied and understood in a more holistic way.

APPENDICES

APPENDIX A: Definitions and Measurements of Guardian(ship)

Table 21. Definitions and Measurements of Guardian(ship)

Author and Publication Date	Definition of Guardian(ship)	Measurement of Guardian(ship)
Cohen & Felson (1979)		Labor force participation and single-adult households.
Cohen & Cantor (1980)	Guardianship is the condition in which specific individuals, be they law enforcement agents or the common citizenry, are actual or potential protectors of the offender's target (formal organizations specifically designed for protective purposes, individuals in the proximity of persons or property). Guardians may be persons who are potentially able to prevent the successful completion of the crime, either by their physical presence alone or by some form of direct action (companions, pedestrians, private security guards, law enforcement officers).	The number of people in the household and major activity (work, keeping house, or being unemployed).

Table 21 (cont'd)

Author and Publication Date	Definition of Guardian(ship)	Measurement of Guardian(ship)
Cohen, Kluegel, & Land (1981)	The effectiveness of persons (housewives, neighbors, pedestrians, private security guards, law enforcement officers) or objects (burglar alarms, locks, barred windows) in preventing violations from occurring, either by their presence alone or by some sort of direct or indirect action.	Household composition and labor-force statuses.
Lynch (1987)	The presence of persons or devices that can prevent or inhibit victimization (professional guards, laymen with an interest in preventing victimization, alarms, etc.).	Frequency of local travel on the job and frequency of overnight trips (guardianship on the job).
Stahura & Sloan III (1988)		Police employment, police expenditure, female labor force nonparticipation.
Miethe, Stafford, & Sloane (1990)		Number of people in the household and daytime and nighttime activity.
Bennett (1991)		Female labor force participation.

Table 21 (cont'd)

Author and Publication Date	Definition of Guardian(ship)	Measurement of Guardian(ship)
Garofalo & Clark (1992)		Household occupancy and the presence of lighting, dogs, alarm systems, neighborhood watches.
Eck & Weisburd (1995)	People who can protect targets (friends, private security guards, public police).	
Felson (1995)	Any person who serves by simple presence to prevent crime and by absence to make crime more likely.	
Rice & Smith (2002)		The number of owner-occupied places, multifamily buildings, single-parent homes, commercial places.
Tewksbury & Mustaine (2003)		Self-protective behaviors (the possession and carrying of self-protective measures such as a weapon).

Table 21 (cont'd)

Author and Publication Date	Definition of Guardian(ship)	Measurement of Guardian(ship)
Tseloni, Wittebrood, Farrell, & Pease (2004)	Refers to the capability of persons and objects to prevent crime from occurring.	Household composition and occupancy, neighbors agree to watch homes, use of self-protection measures, participation in collective crime prevention enterprises.
Coupe & Blake (2006)		Occupancy of housing at time of burglary, detection of burglar (reporting), security devices.
Felson (2006)	Anybody passing by or assigned to look after people or property who keeps an eye on potential targets of crime. This usually refers to ordinary citizens, not police or private guards.	
Wilcox, Madensen, & Tillyer (2007)	Individual-level guardianship is possessing qualities that relate to social ties and interpersonal control. Environmental-level guardianship is the collective degree to which individuals or objects in a bounded locale possess qualities related to social ties and social control.	Individual-level target hardening, neighborhood-level target hardening, home occupancy, informal social control, place management and surveillance, natural surveillance.

Table 21 (cont'd)

Author and Publication Date	Definition of Guardian(ship)	Measurement of Guardian(ship)
Reynald (2009)		Occupation of property, visibility of occupants, occupant(s) monitor property and streets, the willingness of occupant(s) to intervene.
Felson & Boba (2010)	Someone whose presence serves as a gentle reminder that someone is looking or those who engage in natural surveillance, including ordinary citizens going about their daily lives but providing by their presence some degree of security.	
Reynald (2010)	Residential guardians are the crime control agents who are most likely to assume primary responsibility for their residential space, including the people and property contained therein.	Monitoring and intervention.
Sampson, Eck, & Dunham (2010)	Individuals who have the goal of protecting targets. Guardians are highly varied and include normal citizen behavior when they look out for each other and their property, groups of strangers who as a byproduct of their numbers guard each other, and individuals who are specifically employed to protect people and things.	

Table 21 (cont'd)

Author and Publication Date	Definition of Guardian(ship)	Measurement of Guardian(ship)
Hollis-Peel, Reynald, van Bavel, Elffers, & Welsh (2011)	Any person and every person on the scene of a potential crime that may notice and intervene (whether they intend to or not).	
Reynald (2011a)		Visible occupancy (available guardian), monitoring, intervention.
D'Alessio, Eitle, & Stolzenberg (2012)		Burglary rate (weekday, weeknight, weekend), unemployment rate.
Hollis-Peel, Reynald, & Welsh (2012)		Availability, monitoring, intervention.
Breetzke & Cohn (2013)		Population density, road density, community is partially or fully gated.
Hollis, Felson, & Welsh (2013)	The presence of a human element which acts, whether intentionally or not, to deter the would-be offender from committing a crime against an available target.	

Table 21 (cont'd)

Author and Publication Date	Definition of Guardian(ship)	Measurement of Guardian(ship)
Hollis-Peel & Welsh (2014)		Availability of guardians, whether or not the guardians are visibly monitoring and engaging in surveillance, and whether or not the guardians intervene.
Uittenbogaard (2014)		Visibility and surveillance.
Coupe & Fox (2015)		House (target) occupancy, neighbors' occupancy, number and types of all properties, number of roads and paths, security patrol, guardianship objects (CCTV, burglar alarms, dogs, other security devices).

Note: Journal articles using another author's definition of guardianship were not included. Only original definitions were included.

APPENDIX B: Survey Questionnaire

Survey Questionnaire on Intentionally Disguised Handwriting

Instructions: Please answer each of the survey questions and statements below; your responses will remain anonymous. Thank you for your participation.

Part I - General Questions

Please answer the following questions.

1. Do you think the cashiers at your local retail and grocery stores are trained in forgery detection (i.e., trained to identify fake or altered signatures that may be presented to them)?

   (a) Yes
   (b) No

2. If your previous answer was "No," please go to question 3.
   If your answer was "Yes," rate on a scale from 1 to 5, how well you think the cashiers are trained? With 1 being "Poorly trained" and 5 being "Very well trained."

   Poorly Trained Very Well Trained

   1 2 3 4 5

3. What do you think cashiers at stores, restaurants, and banks look for when they compare the signature on your personal identification (i.e., drivers license, passport, ID card, etc.), or on the back of your credit card, to a check or credit card receipt that you have signed?

For the statements below, please select from the following answer choices:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
4. It would be likely for a cashier at Walmart to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5
5. It would be likely for a cashier at Target to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6. It would be likely for a cashier at Meijer to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5
7. It would be likely for a cashier at Kroger (or similar grocery store) to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5
8. It would be likely for a cashier at K-Mart to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5
9. It would be likely for a cashier at MSU Credit Union (or other bank) to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5
10. It would be likely for a cashier at Michigan Department of Motor Vehicles (DMV) to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5
11. It would be likely for a cashier at Olive Garden to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5
12. It would be likely for a cashier at Old Chicago (or similar restaurant) to accept a check or credit card receipt that contains a disguised signature.	1	2	3	4	5

Part II – Scenarios

Scenario #1 – Restaurant Setting (signatures will not be compared)

13. How did you change or alter your original signature to make it appear different? Please provide as much detail as you can.

14. Did knowing that your signatures **were not** going to be compared influence your disguise strategy? How did it influence your strategy? Why?

Scenario #2 – Retail Setting (signatures <u>may or may not be</u> compared)

15. How did you change or alter your original signature to make it appear different? Please provide as much detail as you can.

16. Did thinking that someone **might** compare your signatures influence your disguise strategy? How did it influence your strategy? Why?

Scenario #3 – Bank Setting (signatures <u>will be</u> compared)

17. How did you change or alter your original signature to make it appear different? Please provide as much detail as you can.

18. Did knowing that somebody **for sure would be** comparing your signatures influence your disguise strategy? How did it influence your strategy? Why?

<u>Part III – Classification</u>

Please answer the following questions.

19. What is your age (in years)? _____

20. What is your gender?

    (a) Male
    (b) Female

21. What is your race/ethnicity?

    (a) American Indian or Alaskan Native
    (b) Asian
    (c) Black or African American
    (d) Native Hawaiian or Other Pacific Islander
    (e) White – Non Hispanic
    (f) White – Hispanic
    (g) Other: _____

22. What country are you from? _____

23. What are you currently majoring in? _____

24. What is your highest degree earned?

(a) High School Diploma

(b) Some college

(c) College graduate - Associate degree → Major: _____

(d) College graduate – Bachelor degree → Major: _____

(e) College graduate – Master degree → Major: _____

What was your B.A. or B.S. degree in? _____

(f) College graduate – Doctorate degree → Major: _____

(g) Professional school graduate
(e.g., DVM, MD, Law, etc.)

25. Which hand do you write with?

(a) Right (b) Left (c) Ambidextrous (write with both hands)

26. Have you studied or received any training on forgery detection?

(a) Yes Specify: _____
(b) No

27. Have you ever been a victim of forgery?

(a) Yes Specify: _____
(b) No

28. Have you ever been a victim of identity theft?

(a) Yes Specify: _____
(b) No

APPENDIX C: Consent Form

Consent form for participation in the study entitled:
"Intentionally Disguised Handwriting"

The research study in which you are being asked to participate investigates the kinds of disguise techniques used by individuals who sign a document with the intention of later denying ever signing it. The purpose of this study is to identify the thought process and techniques used by individuals who intentionally disguise their handwriting, and offer some suggestions that will provide forensic document examiners with the appropriate examination techniques in relation to intentionally disguised signatures.

You will be asked to sign your name several times and then asked to sign your name again, but with an attempt to disguise the writing. Following the writing activity you will be asked to take a brief survey regarding your disguise technique and strategy. We estimate that this process will consume no more than 30 minutes of your time.

Every effort will be made to maintain the privacy of your participation. The survey questionnaire and handwriting samples received for this project will be kept confidential and stored in a locked file cabinet in a locked office. Data from this research will be stored on a password protected computer in a locked office, and only research staff and the Michigan State University Human Research Protection Program will have access to the information over the course of the study (approximately 2 years). Your handwriting and any other identifying information will be kept confidential and all information received will be held in strict confidence, and your privacy will be protected to the maximum extent allowable by law. Upon conclusion of the study all handwriting samples will be destroyed. The data we collect may be used for publication or presentation, but your comments and identity will remain anonymous. The sole exception to this is if you agree to allow your handwriting to be used as examples in presentations and/or publications (below).

There is no known risk or direct benefits to you when participating in this study. Your participation in this study is completely voluntary, and you may choose to refuse or discontinue participation in any part of the process, or altogether, without penalty. The investigator(s) will be present when you are reading this form and will clearly answer any questions you have.

If you have any concerns or questions about this research study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher David Foran, Ph.D., by phone (517) 432-5439, email: foran@msu.edu, or regular mail: 560 Baker Hall, East Lansing, MI 48824. If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, e-mail irb@msu.edu, or regular mail at 207 Olds Hall, MSU, East Lansing, MI 48824.

Your signature below indicates your voluntary agreement to participate in this study.

☐ Check here if we may use your handwriting as examples in presentations and/or publications.

☐ Check here if you do not want your handwriting made public in any way.

Signature_____ Date _____

Print Name_____

APPENDIX D*:* Documents used for Handwriting Exercise


Famous Dave's Flint
G3558 Miller Rd
Flint, MI 48507
(810) 720-4600

Date/Time: 2010-04-17 05:33 PM
Order Number: 25326
Account Type: CREDIT
EDC Tran ID: 806248352
Server: ERIN
Table: 43

PURCHASE
APPROVAL

Entry Mode: Swiped
Card Number: XXXXXXXXXXXX
Card Expire: XX/XX
Card Type: Visa
Cardholder Name: R.
Approval Code: 203216
Reference Number:
Acq TranID: 080107778125146
Acq ValCode: WHLW

PURCHASE: $36.09

Gratuity: ______

Total: ______

Cardmember acknowledges receipt of goods and/or services in the amount of the total shown heron and agrees to perform the obligations set forth by cardmember's agreement with issuer

Signature: ______

Figure 8a. Scenario 1 - Restaurant Setting


Walmart
Save money. Live better.
Self Checkout
Fast. Fun. Easy.

Walmart
MANAGER AARON STALLINGS
(517) 622 - 1431
LANSING, MI
ST# 2869 OP# 00009044 TE# 44 TR# 08550
BRANDED HEN 020328911258 F 12.58 N
BRANDED TOM 020344161380 F 13.80 N
DORITOS 002840008298 F 3.48 N
SUBTOTAL 29.86
TOTAL 29.86
VISA TEND 29.86

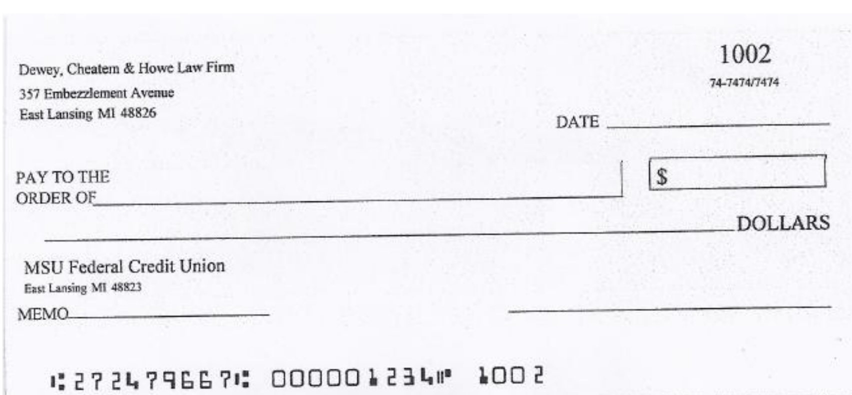
ACCOUNT # 6218
APPROVAL # 022004
TRANS ID - 008033275840985 6
VALIDATION - HT5G
PAYMENT SERVICE - E
CHANGE DUE 0.00

ITEMS SOLD 3

TC# 3314 7575 4920 8849 324

THANK YOU FOR SHOPPING WITH US
11/28/10 16:04:34
CUSTOMER COPY

Figure 8b. Scenario 2 - Retail Setting


Dewey, Cheatem & Howe Law Firm
357 Embezzlement Avenue
East Lansing MI 48826

1002
74-7474/7474

DATE ______

PAY TO THE ORDER OF ______ $ ______

______ DOLLARS

MSU Federal Credit Union
East Lansing MI 48823

MEMO ______

⑆272479667⑆ 0000001234⑈ 1002

Figure 8c. Scenario 3 - Bank Setting

APPENDIX E: Case Scenarios

*Signature **will not** be compared – Restaurant Setting*

Scenario 1. It is Friday evening and you decide to go out and eat at a restaurant of your choice. After you finish your meal, the waitress leaves the check at your table and tells you she will pick it up when you are ready to pay. After a few minutes she comes back and you give her the check and your credit card. When the waitress returns, she thanks you for dining with them and tells you to have a nice evening. You know that the waitress will not compare your signature on the sales receipt to the signature on your driver's license or credit card. Knowing no signature comparison will be made, you decide to disguise (alter) your signature with the intention of later denying ever signing the sales receipt or eating at this restaurant on this date.

After deciding on a disguise strategy, go ahead and sign the sales receipt in front of you.

*Signature **may or may not** be compared – Retail setting*

Scenario 2. It is a Saturday afternoon and you decide to go to Walmart [or your choice of retail store] and do some shopping. After you have completed your shopping and are making your way to the cash register you start to think about whether or not the cashier will ask for your driver's license or not. You know from past experience that sometimes the cashier will take a look at the signature on your driver's license or credit card and compare it to the one on the sales receipt, while at other times they will not ask for any identification at all. After thinking it over you decide that you will disguise your signature with the intention of later denying ever signing the sales receipt and purchasing the items.

After deciding on a disguise strategy, go ahead and sign the sales receipt in front of you.

*Signature **will be** compared – Bank setting*

Scenario 3. Wednesday morning on your way to work you decide to stop off at your bank and make a withdrawal. Thinking about all of the bills you have to pay, you consider trying to disguise your signature with the intention of later denying ever making the cash withdrawal. However, you know that the bank teller will definitely ask for identification and make a comparison of your signatures. Although you know that your ID will be checked and your signatures will be compared, you decide to try and disguise your signature anyway.

After deciding on a disguise strategy, go ahead and sign the sales receipt in front of you.

APPENDIX F: Handwriting Coding Scheme

Handwriting Study Coding Scheme

Elements of Style (ES)
Elements of Execution (EE)
Other (O)

Participant Self-Report (Changes made, Yes or No)

Handwriting Elements	Scenario 1- Restaurant	Scenario 2- Retail	Scenario 3- Bank
Arrangement (ES)	Yes/No	Yes/No	Yes/No
Style of allograph (ES)	Yes/No	Yes/No	Yes/No
Lower case letter form (ES)	Yes/No	Yes/No	Yes/No
Capital letter form (ES)	Yes/No	Yes/No	Yes/No
Spacing (ES)	Yes/No	Yes/No	Yes/No
Connecting Strokes (ES)	Yes/No	Yes/No	Yes/No
Slant (ES)	Yes/No	Yes/No	Yes/No
Size (ES)	Yes/No	Yes/No	Yes/No
Proportions (ES)	Yes/No	Yes/No	Yes/No
Lateral expansion (ES)	Yes/No	Yes/No	Yes/No
Alignment (EE)	Yes/No	Yes/No	Yes/No
Pressure (EE)	Yes/No	Yes/No	Yes/No
Speed (EE)	Yes/No	Yes/No	Yes/No
Hiatuses (EE)	Yes/No	Yes/No	Yes/No
Pen lifts (EE)	Yes/No	Yes/No	Yes/No
Line Quality / Tremor (EE)	Yes/No	Yes/No	Yes/No
Initial Strokes (EE)	Yes/No	Yes/No	Yes/No
Terminal Strokes (EE)	Yes/No	Yes/No	Yes/No
Embellishments (EE)	Yes/No	Yes/No	Yes/No
Simplification (EE)	Yes/No	Yes/No	Yes/No
Abbreviations (EE)	Yes/No	Yes/No	Yes/No
Punctuation/Diacritics (EE)	Yes/No	Yes/No	Yes/No
Legible signature (EE)	Yes/No	Yes/No	Yes/No
Illegible signature (EE)	Yes/No	Yes/No	Yes/No
Handedness (EE)	Yes/No	Yes/No	Yes/No
Writing movement (EE)	Yes/No	Yes/No	Yes/No
Spelling (O)	Yes/No	Yes/No	Yes/No
Order of name (O)	Yes/No	Yes/No	Yes/No

Scientific Detailed Analysis (What changes did the participants actually make)

Handwriting Elements	Scenario 1- Restaurant	Scenario 2- Retail	Scenario 3- Bank
Arrangement (ES)	Yes/No	Yes/No	Yes/No
(Combo of many other elements)			
Style of allograph (ES)	Yes/No	Yes/No	Yes/No
1. Print 2. Cursive 3. Script 4. Combo			
Lower case letter form (ES)	Yes/No	Yes/No	Yes/No
Capital letter form (ES)	Yes/No	Yes/No	Yes/No
Spacing (ES)	Yes/No	Yes/No	Yes/No
Letter: *Word*: 1. Narrow 1. Narrow 2. Moderate 2. Moderate 3. Wide 3. Wide			
Connecting Strokes (ES)	Yes/No	Yes/No	Yes/No
1. Garland 2. Arcade 3. Angular 4. Thread 5. Indeterminable 6. Combo			
Slant (ES)	Yes/No	Yes/No	Yes/No
1. Backward 2. Forward 3. Vertical 4. Combo 5. Indeterminable			
Size (ES)	Yes/No	Yes/No	Yes/No
1. Small 2. Medium 3. Large 4. Extra-Large			
Proportions (ES)	Yes/No	Yes/No	Yes/No
1. Increase slightly 2. Increase greatly 3. Decrease slightly 4. Decrease greatly			

Lateral expansion (ES)	Yes/No	Yes/No	Yes/No
1. Narrow 2. Moderate 3. Wide			
Alignment (EE)	Yes/No	Yes/No	Yes/No
Signature to Baseline: 1. Ascending 1. Above 2. Descending 2. Sitting On 3. Level 3. Below 4. Combo			
Pressure (EE)	Yes/No	Yes/No	Yes/No
1. Heavy 2. Medium 3. Light			
Speed (EE)	Yes/No	Yes/No	Yes/No
1. Fast 2. Medium 3. Slow			
Hiatuses (EE)	Yes/No	Yes/No	Yes/No
1. One 2. Two 3. Three 4. Four or more			
Pen lifts (EE)	Yes/No	Yes/No	Yes/No
1. One 2. Two 3. Three 4. Four or more			
Line Quality / Tremor (EE)	Yes/No	Yes/No	Yes/No
1. Poor w/tremor 2. Poor without tremor 3. Good without tremor 4. Excellent without tremor			
Initial Strokes (EE)	Yes/No	Yes/No	Yes/No
Start *Location* 1. Blunt 1. Top (12pm) 2. Feathery 2. Bottom(6pm) 3. Right (3pm) 4. Left (9pm) 5. Upper right 6. Upper left 7. Lower right 8. Lower left			

Terminal Strokes (EE)	Yes/No	Yes/No	Yes/No
Start 1. Blunt 2. Feathery *Location* 1. Top (12pm) 2. Bottom(6pm) 3. Right (3pm) 4. Left (9pm) 5. Upper right 6. Upper left 7. Lower right 8. Lower left			
Embellishments (EE)	Yes/No	Yes/No	Yes/No
1. Capital letters 2. Lower case letters 3. Beginning stroke 4. Ending stroke 5. Under signature 6. Combo			
Simplification (EE)	Yes/No	Yes/No	Yes/No
1. Capital letters 2. Lower case letters 3. Beginning stroke 4. Ending stroke 5. Under signature 6. Combo			
Abbreviations (EE)	Yes/No	Yes/No	Yes/No
1. Eliminate letters 2. Letter combos that sacrifice form for speed 3. Middle initial instead of full name. 4. Change number of letters in the abbreviation.			
Punctuation/Diacritics (EE)	Yes/No	Yes/No	Yes/No
Form 1. i-dot 2. Period 3. t-bar 4. Combo *Location* *i-dot/j-dot* 1. Above stem 2. Close to stem 3. Right of stem 4. Left of stem *t-bar* 1. Top of stem 2. 3/4 of stem 3. Middle-stem 4. Low-stem			
Legible signature (EE)	Yes/No	Yes/No	Yes/No
1. All letters well formed and readable. 2. Most letters well formed and readable.			

Illegible signature (EE)	Yes/No	Yes/No	Yes/No
1. Letters are not well formed and un-readable. 2. Only one or two letters are readable, the rest are loops and lines. 3. Writing consists of loops and lines only.			
Handedness (EE)	Yes/No	Yes/No	Yes/No
1. Right hand 2. Left hand 3. Combo			
Writing movement (EE)	Yes/No	Yes/No	Yes/No
1. Garlanded 2. Arched 3. Angular 4. Indeterminable			
Spelling (O)	Yes/No	Yes/No	Yes/No
1. Add letters 2. Delete letters 3. Change vowels (e.g., e to i) 4. Change consonants (e.g., s to c) 5. Combo			
Order of name (O)	Yes/No	Yes/No	Yes/No
1. First, middle, last 2. First, last, middle 3. Last, first, middle 4. Last, middle, first 5. Middle, last, first 6. Middle first, last 7. First, last 8. Last, first			

APPENDIX G: List of Handwriting Variables

List of Handwriting Variables[28]

Abbreviations (Abbreviations): A shortened form of a word or title.

Alignment (Align_Spec1, Align_Spec2): The spatial organization of the writing pattern, its linear arrangement of words and intervening spaces, and their accommodation on the page.

Connecting Strokes (ConnectStrokes): The fusion of the terminal stroke of one lowercase cursive letter and the initial stroke of another.

Embellishment (Embell): Unnecessary ornamentation or elaborative additions to the design of the letters or words.

Handedness (Hand): The tendency of the writer to use either the right or the left hand more naturally than the other.

Hiatuses (Hiatuses): A gap in a writing stroke of a letter formed when the writing instrument leaves the paper; an opening; an interruption in the continuity of a line.

Initial Stroke (Instroke_Start, Instroke_Dir): The first stroke of a letter or word.

Lateral Expansion (LatExpansion): The horizontal dimension of writing produced by the width of letters and the space between letters and words.

Legibility (Legible Sig): The ease with which a reader recognizes individual letter and character shapes.

Letter Form (LetterForm_First, LetterForm_Last): The graphic form of any lowercase or uppercase letter of the alphabet.

Line Quality (Line Quality): The degree of regularity (i.e., smoothness or gradation) in the written stroke as may be judged from the consistency of its path in a prescribed direction. It varies from smooth and controlled to tremulous and erratic.

Order of Name (Order): The arrangement of the first, middle, and last name.

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Pen Lifts (Pen Lifts): An interruption in a stroke due to the removal of the writing instrument from the paper.

Pressure (Pressure): The amount of force exerted on the point of the writing instrument. It can be determined by the amount of indentation in the paper surface.

Punctuation (Pun_i/j-dot Form, Pun_i/j-dot Loc, Pun_period): The marks used in writing to separate sentences and their elements, and to clarify meaning (e.g., period, comma). An i-dot (and a period) is a minute, roundish, solid mark.

Size (Size_Absolute): The absolute writing size is the distance between the top of the upper zone and the bottom of the lower zone.

Slant (Slant): The angle of the axis of letters relative to the baseline of the writing.

Spacing (Spacing_Letters): The distance between letters or words.

Speed of Writing (Speed): The rate of line generation.

Spelling (Spelling): The way a word is spelled; the way letters are grouped to form a word.

Style of Allograph (StyleofAllograph): A style (block capital, print script, or cursive form) of one of the 26 letters of the English alphabet.

t-bar (t-bar_Loc, t-bar_Form): A stroke intersecting the stem or main portion of the lowercase or uppercase letter "T".

Terminal Stroke (Tstroke_End, Tstroke_Dir): The last stroke of a word; endstroke.

APPENDIX H: Images Showing Intentional Handwriting Changes

Figure 9. Examples of altered signatures in scenario 1

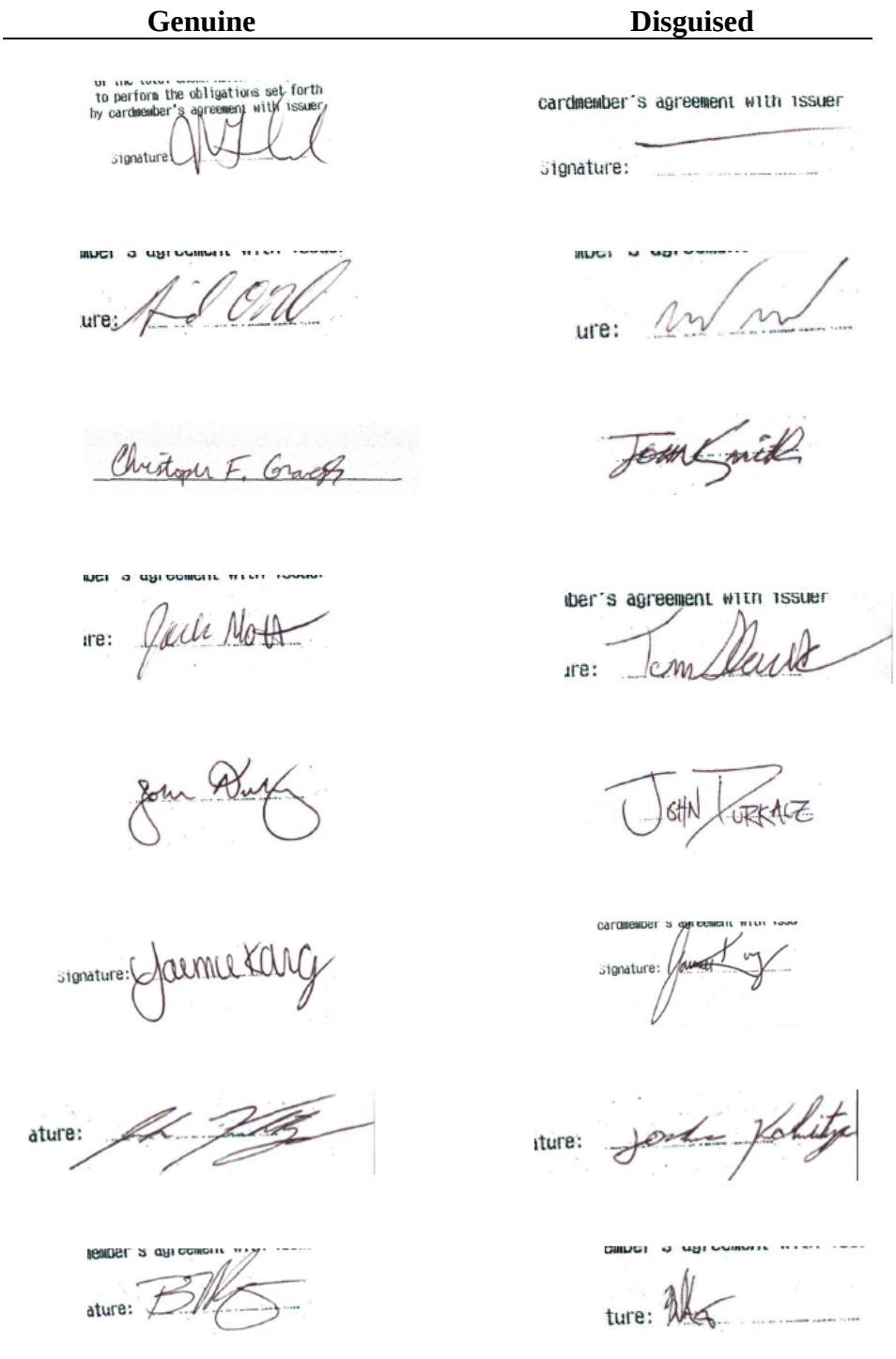


Figure 10. Examples of altered signatures in scenario 2

Figure 11. Examples of altered signatures in scenario 3

Examples of altered signatures across scenarios

Figure 12. Example #1

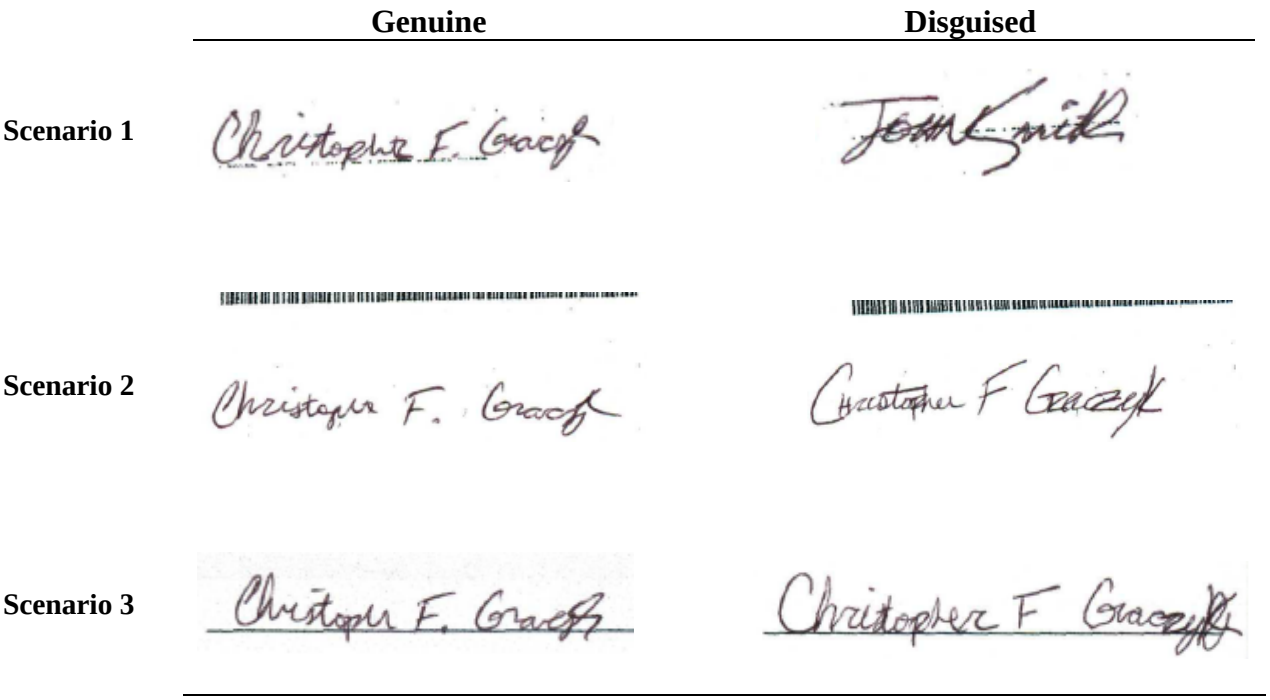


Figure 13. Example #2

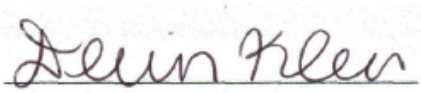
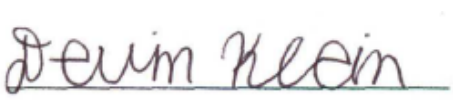
	Genuine	Disguised
Scenario 1		
Scenario 2		
Scenario 3		

Figure 14. Example #3

	Genuine	Disguised
Scenario 1		
Scenario 2		
Scenario 3		

Figure 15. Example #4

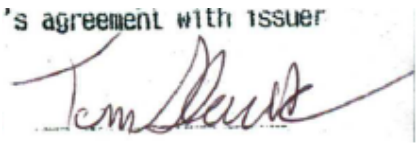
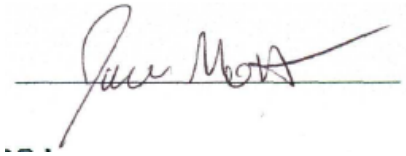
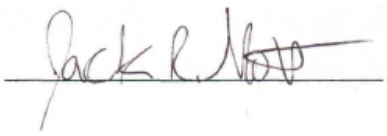
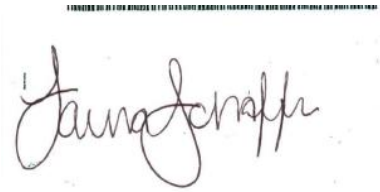
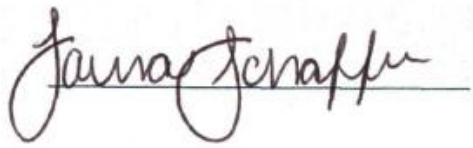
	Genuine	Disguised
Scenario 1		
Scenario 2		
Scenario 3		

Figure 16. Example #5

	Genuine	Disguised
Scenario 1		
Scenario 2		
Scenario 3		

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