

2016

Graphological Analysis: A Potential Psychodiagnostic Investigative Method for Deception Detection

Michelle R. Doscher
Walden University

Follow this and additional works at: <https://scholarworks.waldenu.edu/dissertations>

 Part of the [Psychology Commons](#)

This Dissertation is brought to you for free and open access by the Walden Dissertations and Doctoral Studies Collection at ScholarWorks. It has been accepted for inclusion in Walden Dissertations and Doctoral Studies by an authorized administrator of ScholarWorks. For more information, please contact ScholarWorks@waldenu.edu.

Walden University

College of Social and Behavioral Sciences

This is to certify that the doctoral dissertation by

Michelle R. Doscher

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee

Dr. Sandra Caramela-Miller, Committee Chairperson, Psychology Faculty

Dr. Rachel Moore, Committee Member, Psychology Faculty

Dr. Richard Thomlinson, University Reviewer, Psychology Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2016

Abstract

Graphological Analysis: A Potential Psychodiagnostic Investigative Method for
Deception Detection

by

Michelle R. Doscher

MS, National University, 1993

BS, University of Tennessee at Martin, 1991

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Forensic Psychology

Walden University

November 2016

Abstract

False confessions and unproductive criminal investigations have resulted in misidentification of verbal and nonverbal deceptive cues. Further, the association of deceptive behavioral responses has not been confirmed based upon quantifiable graphological discrepancies. Guided by the 4-factor model for deceptive behavior, the purpose of this study was to explore the relationship between psycholinguistic cues and graphological spacing discrepancies. Handwriting samples were gathered from a stratified group of college students and law enforcement officers in rural Illinois and Tennessee ($n = 113$). The research was designed to determine whether graphological spacing discrepancies were evident in left margin indentions, word spacing, and sentence spacing. Two-way analyses of variance by ranks were conducted, combining these spacing discrepancies in a way to maximize the differences between the groups of truthful and deceptive statements. Through multiple regression analyses, the contributing variances were explained, as seen from participants' multiple psychological inventory scores and total spacing variances. Two-way analyses of variance were also conducted with the intent of discovering whether an interaction effect occurred, between deception-induced cognitive load and spontaneous or memory-related influences on graphological traits. Results were confirmed for statistically significant differences between truthful and deceptive sentences, containing spacing variances. Implications for positive social change include fewer false confessions during police investigations and interrogation reports with empirically based findings.

Graphological Analysis: A Potential Psychodiagnostic Investigative Method for

Deception Detection

by

Michelle R. Doscher

-MS, National University, 1993

BS, University of Tennessee at Martin, 1991

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Forensic Psychology

Walden University

November 2016

Dedication

I would like to dedicate this work to my loving parents, adoring husband, amazing sons, and dear family and friends who have never doubted my abilities to achieve my life goals. Thank you for your continued prayers and words of encouragement. I love you all!

Acknowledgments

I would like to thank my committee members, Dr. Sandra Caramela-Miller, Dr. Rachel Moore, and Dr. Richard Thomlinson for their insightful comments and encouragement, in addition to their patience, motivation, and immense knowledge. Their guidance was instrumental in writing this dissertation. My research would not have been possible without the assistance of the criminal justice faculty and students of Rend Lake College, Ina, Illinois; Mount Vernon Police Department, Mount Vernon, Illinois; Jefferson County Sheriff's Department, Mount Vernon, Illinois; and McKenzie Police Department, McKenzie, Tennessee. Thank you all for your voluntary participation and time.

Table of Contents

List of Tables	v
List of Figures	vi
Chapter 1: Introduction to the Study.....	1
Introduction.....	1
Background	2
Problem Statement	4
Purpose of the Study	7
Research Questions and Hypotheses	8
Theoretical Framework.....	13
Nature of the Study	16
Definitions.....	17
Assumptions.....	19
Scope and Delimitations	20
Limitations	22
Significance.....	23
Summary.....	24
Chapter 2: Literature Review	27
Introduction.....	27
Synopsis of Current Literature.....	27
Chapter Preview.....	30
Literature Search Strategy.....	30

Theoretical Foundation	32
Theoretical Propositions of Handwriting and the Four-Factor Model of Deception	33
Delineations of Assumptions	39
Examples of Previously Applied Theories to Deception Detection	40
Rationale for Theory Choice.....	41
Theory and Research Study Relationship.....	43
Research Questions Related to Research Challenges	44
Literature Review Related to Key Variables	46
Related Studies Consistent with Scope of Study	47
Previous Research Approaches to Key Variables.....	50
Rationale for Selection of Variables.....	52
Studies Related to Key Variables	55
Studies Related to Research Questions.....	58
Summary and Conclusions	58
Chapter 3: Research Method.....	62
Introduction.....	62
Research Design and Rationale	63
Variables	63
Connection to Research Questions	65
Design Constraints and Consistency in Design Choice.....	66
Methodology.....	67

Procedures for Participation, Recruitment, and Data Collection	69
Instrumentation and Operationalization of Constructs	71
Data Analysis	75
Threats to Validity	79
Internal and External Validity.....	79
Ethical Procedures	80
Summary	81
Chapter 4: Results	84
Introduction.....	84
Data Collection	87
Results.....	88
Descriptive Statistics.....	90
Statistical Assumptions.....	92
Statistical Analyses	95
Research Questions.....	100
Summary	105
Chapter 5: Discussion, Recommendations, and Conclusion	108
Introduction.....	108
Key Findings.....	109
Interpretation of Findings	111
Interpretations Based on Theoretical Framework.....	114
Limitations of the Study.....	119

Recommendations.....	121
Implications.....	122
Conclusion	124
References.....	127
Appendix A: Permission Letter for Cognitive Flexibility Inventory.....	141
Appendix B: Permission Letter for Unethical Deception Scale	142
Appendix C: Measuring Protocol	143

List of Tables

Table 1. Group Characteristics as a Percentage of the Sample Data.....	88
Table 2. Median Spacing Discrepancies by Categories.....	91
Table 3. Spacing Discrepancy – Spontaneity and Cognitive Load.....	91
Table 4. Spacing Discrepancy – Memory-based Writing and Cognitive Load	92
Table 5. Hierarchical Multiple Regression, Independent Variables by Models	92
Table 6. Hierarchical Multiple Regression, Importance of Added Variables.....	100

List of Figures

Figure 1. Independent variables, spontaneity and cognitive load.....98

Figure 2. Independent variables, memories and cognitive load.....99

Chapter 1: Introduction to the Study

Introduction

Graphology, as a psychodiagnostic method for deception detection, has not been proven as a valid and reliable research method (Bradley, 2011). The criminal justice system in the United States rejects graphological analyses as a psychodiagnostic instrument for criminal investigations (Bradley, 2011). Researchers do not know whether psycholinguistic deceptive cues, detected in verbal and some nonverbal cues, carry over into handwritten statements (McQuaid, Woodworth, Hutton, Porter, & ten Brinke, 2015). Lin, Xie, Chen, and Tang (2013) confirmed correlations between cognitive load and some handwriting traits. Luria, Kahana, and Rosenblum (2014) compared deceptive and truthful handwritten statements, using a Computerized Penmanship Evaluation Tool. Neither research team addressed the possible effects of spontaneous emotions or reactions to deception, on handwriting traits.

In an effort to fill the gap these researchers left, the focus of this study was exploring whether internally-produced, deceptive psycholinguistic cues, manifested as graphological discrepancies, depended on the scenario's content and context. In addition to filling this gap in the research, there was also interest in another area, sparked by current discussions and debates about justice reinvestment incentives (Byrne, 2014). Improvements in law enforcement investigative procedures are needed. As a result of this need, a method for more productive investigations was explored in this study. Graphological discrepancies were investigated for possible cues to deception detection.

The implications for positive social change, as a result of the current research, could be significant. The eventual creation of a standardized psychodiagnostic deception detection method, yielding greater productivity for interviews and interrogations, is a possibility. Such a method for discerning truthful from deceptive testimonies written by witnesses and suspects may also have a money-saving impact on criminal justice budgets. When citizens perceive police investigations as competent and fair, the citizens are more willing to identify and cooperate with law enforcement. Legitimacy in policing parallels a sense of social inclusion resulting in a greater understanding of the need for law and order (Bradford, 2014).

In the remainder of Chapter 1, handwriting was introduced as a nonverbal form of communication, receptive to behavioral influences. Gaps in research, leading to justifying graphological analysis as a deception detection method, were addressed. Evidence was presented, reiterating the complexity of deception detection due to involved cognitive and social developments. The quasi-experimental research design served as the platform for this study, to discover whether quantitative graphological discrepancies accurately depict deceptive cues in handwriting. Supporting pillars of research and theories pertaining to deception, behavioral leakage, and handwriting idiosyncrasies, served as the framework.

Background

Written statements are expressions of communication and subconscious thought (Morgan, Colwell, & Hazlett, 2011). Behavioral leakages in participants' handwriting, a nonverbal behavior, was expected when aligned with previous behavioral leakage and

deception theories (Zuckerman & Driver, 2014). Handwritten statements were used, as a possible indirect method for lie detection. Researchers identify behavioral fluxes in interrogations and interviews, to answer questions about the verification of senders' emotions and confidence in their statements (Ulatowska, 2014). As a result of this research, the same answers, along with tangible evidence, may be provided.

Most present-day graphologists are not educated in psychology, nor have they studied the theoretical foundations, associated with personality and dependent idiosyncrasies of handwriting (Kučera & Havigerová, 2011). Researchers commonly ask participants, either to copy some or all of the material for handwriting analyses, or to create writing samples based on instructed guidelines (Luria et al., 2014; Tang, 2012). The above methods are not conducive to measuring the combined effects of written content and context, along with spontaneity, for identification of behavioral fluxes. In this study, participants were asked to watch prerecorded movie clips and write statements regarding veracity in response to written directions. The effects of spontaneity on behavioral fluxes were identified and measured.

On average, research participants are 54% accurate when determining veracity of verbal statements (Granhag, Verschuere, & Vrij, 2015). Researchers have achieved higher accuracy rates with multiple methods for statement validity analysis, despite the absence of a single universal deception detection cue (Granhag et al., 2015). If empirical evidence for graphological analyses is collected, analyzed, and validated, then low accuracy rates do not have to be the norm. For this to occur, operationalization of deception variables must be present. Hartwig and Bond (2014) suggested deception

detection remains stable from multiple cues, across various content and contexts. An appeal for quantitative analysis of deceptive written statements, produced under cognitive load in varying contexts, subsists (Lin et al., 2013). Language, demographics, and gender do not affect individual variances seen in graphological analyses, which serve to support the value as an investigative method (Tang, 2012).

In order to establish graphology, as a psychodiagnostic method for deception detection, a valid and reliable research method needs to be created and implemented (Bradley, 2011). To meet this need, the goal for this study was an application of known theories and methods, relating to deceptive behavior and behavioral leakages, to previous graphological research (Lin et al., 2013; Tang, 2012; Zuckerman & Driver, 2014). An attempt was made to create a reliable method for detecting possible deception cues in handwriting. A need continues for enhanced investigative methods, to foster trust and legitimacy among citizens (Bradford, 2014; Byrne, 2014). This research was designed to answer these calls and to potentially satisfy both research needs. Concurrently collecting quantitative nonverbal graphological cues, along with behavioral and cognitive traits affecting a person's demeanor, could provide an objective view of deception, not easily detected in verbal statements.

Problem Statement

Deception detection is complex due to the involved social and cognitive developments (Cui et al., 2013; Granhag et al., 2015). The complexity lies, not in identifying deceptive cues, but in the deception detectors' ability to interpret behavioral differences, between deceivers and truth tellers (Hartwig, Voss, & Wall, 2015). People

rarely rely on the wrong deception cues. Rather, people tend to associate wrong emotions and behaviors to the perceived deception cues (Hartwig & Bond, 2011), thereby misinterpreting behavioral differences. For example, a downward glance or fidgeting hands during questioning does not necessarily mean the person is being deceptive. Several displays of emotions are universal (García-Higuera, Crivelli, & Fernández-Dols 2015); furthermore, as an individual's display of emotions can vary depending on the situation at hand (Granhag et al., 2015).

Researchers have examined the effects of cognitive load on writing features, as well as overall emotional influences of truth or deception on writing traits (Lin et al., 2013; Luria et al., 2014). These previous researchers did not confirm whether psycholinguistic cues, such as hesitations in speech, carried over into handwritten statements (McQuaid et al., 2015). The question also remains, why deception detection studies' accuracy rates are typically not much better than 50% (Granhag et al., 2015). Perhaps, researchers make the assumption, everyone lies in the same manner. Almela, Valencia-Garcia, and Cantos (2013) noted many studies do not compare truthful and untruthful texts, which would contribute to a better understanding of the idiosyncrasies in deceptive writing. Also, baseline written statements are not established for comparison and detection of writing patterns. Although Almela et al. used baseline comparison statements, the deceptive writing was not spontaneously produced. Spontaneously produced lies are less likely to be based on working memories, along with providing fewer details relating to spatial arrangements (McCornack et al., 2014). The belief is,

spontaneous behavior contributes to the leaking of these cognitively controlled traits, such as spacing discrepancies.

As previously mentioned, the social and cognitive traits involved in deception are what make its detection difficult. One method currently used in deception detection is the Scientific Analysis Content (SCAN) method for detecting deception in statements. SCAN, not only lacks standardized methods for identifying deception, but also defines the location of the emotion in the statement, not its presence, as a veracity signal (Bogaard, Meijer, Vrij, Broers, & Merckelbach, 2014). Not surprisingly, Bogaard et al. (2014) found the inter-rater reliability of the SCAN method to be low. Other researchers coded statements using Reality Monitoring (RM) and SCAN criteria (Nahari, Vrij, & Fisher, 2012). The RM coded statements showed significant discrimination between truths and lies. In stark contrast to the RM statements, the SCAN coded statements did not show significant veracity discriminations (Nahari et al., 2012). Unlike SCAN, Criteria Based Content Analysis (CBCA) and RM considered the presence of emotions, not their location, as a sign of veracity (Bogaard et al., 2014). After reviewing these studies, previous researchers' conclusions were confirmed. Recognizing intuitive notions and aligning behavioral differences with deception cues, are important (Hartwig & Bond, 2014).

A reliable, standardized, quantitative method of analysis has not been established for identifying deceptive cues (Bradley, 2011; Burgoon, Schuetzler, & Wilson, 2014). Masip, Bethencourt, Lucas, Sánchez-San Segundo, and Herrero (2012) conducted a deception detection study on handwritten statements. The researchers compared the

readers' identified deceptive cues to the Linguistic Inquiry Word Count (LIWC) software's category results. Only one category of related deceptive cues was identified by both the readers and the LIWC program. For the majority of the results, the readers' interpretation of the written emotions was contradictory to the software's identification of emotion (Masip et al., 2012). The social and cognitive traits, involved in deception, are what make identifying the behaviors involved with deception, difficult. The lack of focus on these traits reveals a significant gap in the research. A quantitative graphological method, which that correctly identifies written psycholinguistic deceptive cues created concomitantly under cognitive load and including spontaneous conditions to simulate behavioral affects under field conditions, was not available. Performing this research was the first step to creating, and eventually validating, the above method to be used as a standardized tool for deception detection.

Purpose of the Study

This quantitative study was designed to explore whether internally-produced, deceptive psycholinguistic cues manifested as graphological discrepancies, depending on the scenario's content and context. The key independent variables (IV) were truthful or deceptive handwritten statements. The IV cognitive load, produced in the form of number and word strings, simulated outside stressors and distractors often seen in field conditions. The dependent variable (DV), graphological spacing discrepancies, encompassed left margin, word, and sentence spacing variances. The IVs were measured and compared to the DV, graphological spacing discrepancies, to determine the presence or absence of psycholinguistic deceptive cues.

Indirect relationships between deception-induced cognitive load and possible influences on graphological traits were also explored. Behavioral traits, such as moral disengagement, were measured using psychological inventories and compared to graphological samples, to investigate possible influences on maintaining consistent graphological spacing. In order for graphological deception detection research to progress, this study was designed to examine graphological spacing variances, with the intent of correctly identifying written psycholinguistic deceptive cues. To date, a study, exploring this indirect approach to deception detection has not been examined under similar laboratory conditions, or published.

Research Questions and Hypotheses

Seven research questions were investigated, in order to achieve the exploration of deceptive psycholinguistic cues, behavioral and cognitive traits on graphological discrepancies. The null (H_0) and alternative (H_a) hypotheses follow each research question. The DV, graphological spacing discrepancies, is divided into three DVs for each of Research Questions 1 and 2. The IVs are defined under each research question.

Research Question 1: Whether graphological discrepancies are evidenced through analysis of left margin indentions, word spacing, and sentence spacing, in efforts to detect deceptive sentences. The DVs were left margin spacing variances, word spacing variances, and sentence spacing variances. The IV was deceptive sentences. Significant changes in graphological spacing were interpreted as writing pattern discrepancies. The frequency of discrepancies was evident when delineating deceptive versus truthful sentences.

H_{01} : Deceptive sentences will not have left margin spacing variances greater than, or equal to twice the previous, or following measured margins.

H_{a1} : Deceptive sentences will have left margin spacing variances greater than, or equal to twice the previous, or following measured margins.

H_{02} : Deceptive sentences will not have word spacing variances greater than, or equal to twice the previous, or following measured word spacing.

H_{a2} : Deceptive sentences will have word spacing variances greater than, or equal to twice the previous, or following measured word spacing.

H_{03} : Deceptive sentences will not have sentence spacing variances greater than, or equal to twice the previous, or following measured sentence spacing.

H_{a3} : Deceptive sentences will have sentence spacing variances greater than, or equal to twice the previous, or following measured sentence spacing.

Research Question 2: Whether the lack of graphological discrepancies are evidenced through analysis of left margin indentions, word spacing, and sentence spacing, in efforts to detect truthful sentences. The DVs were left margin spacing variances, word spacing variances, and sentence spacing variances. The IV was truthful sentences. Significant changes in graphological spacing were interpreted as writing pattern discrepancies. The frequency of discrepancies was evident when delineating truthful versus deceptive sentences.

H_{04} : Truthful sentences will have left margin spacing variances greater than, or equal to twice the previous, or following measured margins.

H_{a4}: Truthful sentences will lack left margin spacing variances greater than, or equal to twice the previous, or following measured margins.

H₀₅: Truthful sentences will have word spacing variances greater than, or equal to twice the previous, or following measured word spacing.

H_{a5}: Truthful sentences will lack word spacing variances greater than, or equal to twice the previous, or following measured word spacing.

H₀₆: Truthful sentences will have sentence spacing variances greater than, or equal to twice the previous, or following measured sentence spacing.

H_{a6}: Truthful sentences will lack sentence spacing variances greater than, or equal to twice the previous, or following measured sentence spacing.

Research Question 3: Whether or not less mental flexibility, as measured by the Cognitive Flexibility Inventory (CFI), has an effect on a participant's ability to maintain consistent graphological spacing. The DV was graphological spacing discrepancies, and the IVs were CFI scores and cognitive load. As greater cognitive load is placed on executive functioning, less mental flexibility occurs, further expecting to affect a subject's ability to maintain consistent graphological spacing. The CFI measured participants' cognitive flexibility, and in turn, the indirect relationship of cognitive load's effects on graphological spacing.

H₀₇: Participants scoring lower on the CFI will not reveal more graphological spacing discrepancies than those scoring higher on the CFI.

H_{a7}: Participants scoring lower on the CFI will reveal more graphological spacing discrepancies than those scoring higher on the CFI.

Research Question 4: Whether spontaneously, versus nonspontaneously, produced deceptive writing exhibits variances in graphological spacing. The DV was graphological spacing discrepancies, and the IVs were spontaneously produced deceptive writing and cognitive load. Due to situation and context, some deception arises spontaneously while other types of deception may be planned or rehearsed. The expectation was, spontaneously produced written deceptive statements would exhibit greater effects of cognitive load, thereby producing greater graphological spacing discrepancies.

H₀8: Participants' deceptive writing will not demonstrate more graphological spacing discrepancies during spontaneous, versus nonspontaneous writing.

H_a8: Participants' deceptive writing will demonstrate more graphological spacing discrepancies during spontaneous versus nonspontaneous writing.

Research Question 5: Whether participants' scores for moral disengagement and unethical work behavior, as measured by the Unethical Deceptive Scale (UDS), correlate with graphological spacing discrepancies. The DV was graphological spacing discrepancies, and the IVs were cognitive load and UDS scores, for moral disengagement. Moral disengagement and unethical work behavior, affects a person's deceptive behavior. The relative contribution of the IVs, to the total variance, was explained.

H₀9: Participants scoring higher on the UDS for moral disengagement and unethical work behavior will not reveal fewer graphological spacing discrepancies, than those scoring lower on the UDS.

H_{a9}: Participants scoring higher on the UDS for moral disengagement and unethical work behavior will reveal fewer graphological spacing discrepancies, than those scoring lower on the UDS.

Research Question 6: Whether written statements void of personal memories show increased graphological discrepancies. The DV was graphological spacing discrepancies, and the IVs were writing, based on personal memories, and cognitive load. Deceptions sometimes result, when people need to quickly solve problems. Typically, when no working memories are available for lie construction, cognitive load is increased, thereby, producing greater graphological spacing discrepancies.

H₀₁₀: Participants' writing based on personal memories, will not demonstrate fewer graphological discrepancies, than participants' writing void of personal memories.

H_{a10}: Participants' writing based on personal memories, will demonstrate fewer graphological discrepancies, than participants' writing void of personal memories.

Research Question 7: Whether participants' scores on the Working Memory and Inhibit domains, measured by the Behavior Rating Inventory of Executive Function[®]-Adult Version (BRIEF[®]-A), correlate with participants' graphological spacing discrepancies. The DV was graphological spacing discrepancies, and the IVs were Working Memory and Inhibit domains scores, and cognitive load. In cases of routine deception, working memories exist, and cognitive load is usually

less. Deceivers' specific cognitive domains, in the laboratory setting and surrounding a lie, affect how deception is influenced, by cognitive efforts and attempted behavioral control. These influences were detected in the BRIEF[®]-A Inventory domains, Working Memory and Inhibit.

H₀₁₁: Participants scoring high in the Working Memory and Inhibit domains of the BRIEF[®]-A Inventory, will not display fewer graphological spacing discrepancies, than those with lower scores in the corresponding domains.

H_{a11}: Participants scoring high in the Working Memory and Inhibit domains of the BRIEF[®]-A Inventory, will display fewer graphological spacing discrepancies, than those with lower scores in the corresponding domains.

Theoretical Framework

Zuckerman's four-factor model for deceptive behavior was the basis for the theoretical framework (Zuckerman, DePaulo, & Rosenthal, 1981). Ekman and Cordaro's (2011) emotional response theory and Jacob et al.'s (2012) deceptive behavior leakage theories complete the triad of foundational theories for this study. Other theories play pivotal roles in emphasizing handwriting's engrained tendencies (Haveripeth, 2013) despite outside stressors (Lin et al., 2013; Tang, 2012) and attempts to mask behavior. Handwriting is a permanent snapshot of an individual's emotional state (Schuetz, 2013), justifying handwriting as a plausible mode for deceptive cues. Yet, comparisons of executive functioning skills and deception are limited (Evans & Lee, 2011; McCornack, 2015; Visu-Petra, Miclea, Buş, & Visu-Petra, 2014).

Handwriting is a nonverbal behavior, expected to present behavioral leakages, when aligned with previous emotional response and deception theories (Zuckerman & Driver, 2014). Emotional responses are automatic and influenced by life experiences (Ekman & Cordaro, 2011). Deceptive people intend to mask their emotions. Lying leads to emotional changes in the person telling the lie. Even the slightest changes, will entice individuals to try to control their behavior (Zuckerman et al., 1981). These changes lead to increased cognitive load. Typically, the body gives up clues to deceptive behavior, under increased cognitive load. This is referred to as leakage (Jacob et al., 2012).

Based on analyses of handwriting habits, Haveripeth (2013) posited by not restricting attention to pictorial appearances, a person's engrained graphological tendencies become more noticeable. These mannerisms and idiosyncrasies are not easily discarded, or masked (Haveripeth, 2013). Combining the preceding observations, the expectation was a change in graphological spacing as a person's behavior changed, when transitioning from writing truthful, to deceptive statements. Changes in graphological spacing, possibly mimicking a parabolic curve, would be expected with an apprehensive or stressed state (Lin et al., 2013; Tang, 2012). Individuals mask or reduce engrained idiosyncrasies during a stressed state, and these actions are not easily discarded (Haveripeth, 2013).

Handwriting, mimicking typical speech patterns was expected. An increase or decrease in pauses or hesitations in speech, is seen when transitioning between deceptive and truthful states (Jacob et al., 2012). An individual's deception proportionally increases, with added cognitive load, because the individual tries not to discredit him or

herself (Jacob et al., 2012). There was anticipation for an increase in space width between sentences or words, as the lying individual pauses to reorganize or to remember truthful thoughts (Lin et al., 2013). Multiple cognitive and behavioral courses of deception continue to complicate deception detection. An introduction to more research and detailed explanations of complimenting theories are presented in Chapter 2.

Handwriting is brainwriting, beginning with neural impulses from our subconscious (Schuetz, 2013). Therefore, handwriting is a permanent snapshot of an individual's emotional state. This characteristic contributes plausibility to analyzing participants' handwriting for possible psycholinguistic cues to deception. Yet, comparisons of executive functioning skills and deception are limited. Evans and Lee (2011) noted relationships between working memory skills and deceptive statements of minors, but Evans and Lee failed to support the assumption inhibitory control skills are necessary when choosing to lie. This assumption was investigated further through possible indirect relationships between cognitive flexibility and graphological spacing discrepancies. Contrary to previous deception studies, Visu-Petra et al. (2014) discovered subjects with greater executive functioning skills, specifically spatial working memory, were poorer liars. Follow-up investigations were performed by exploring relationships between working memory, inhibitions, and graphological spacing discrepancies.

Because people do not lie similarly within all contexts, individual spacing discrepancies were compared in known truthful and deceptive sentences. The possible effects of spontaneity and working memory on graphological spacing were analyzed, in a

further effort to correctly identify deceptive cues. While attempting to prevent wrong emotions and behaviors from being associated with deceptive cues, individuals' cognitive- and behavioral-induced deceptive cues were investigated. This was- achieved by comparing specific cognitive and behavioral domain scores to graphological spacing discrepancies.

Nature of the Study

The selected method was a quasi-experimental design, used to investigate human behavior (Creswell, 2014). Truthful and deceptive written statements were analyzed for graphological spacing discrepancies. Then, possible relationships between the graphological discrepancies and specific cognitive and behavioral domain scores were examined. A potential goal was identification of influences for deception, when combining cognitive efforts and attempted behavioral control, so future deceptive behaviors may be predicted.

Truthful and deceptive handwritten statements are the key IVs. Other IVs include scores from specific cognitive and behavioral domains and cognitive load, as demonstrated by increased mental demands. Cognitive load increased chances for the body to reveal deceptive cues, and cognitive load simulated mental demands, not typically found in laboratory settings. The DV was graphological spacing discrepancies in handwritten statements, further defined as inconsistencies in left margins, spacing between words, and spacing between sentences. Through the examination of the quantifiable DV, empirically-based veracity judgments can be made during investigations and in judicial proceedings.

Participants were law enforcement officers and college students, randomly assigned to experimental and control groups. Both groups produced prewriting and post writing samples of truthful statements, to establish a baseline for writing comparisons. According to instructions, the groups either produced truthful or untruthful writing samples after watching recorded movie clips. For spontaneity, the participants were informed of the writing sample type they would produce after watching each video. Writing samples were produced within a predetermined time frame, further adding a known stressor during the writing exercises. Multiple movie clips were used for variation of content. To the participants, all directions and stated time limitations appeared to be randomly assigned. Yet, the directions were predetermined to control the context under which the samples were written. To simulate stresses sometimes found in investigative situations, the experimental groups produced writing samples with added cognitive load.

A National Institute of Standards and Technology (NIST) traceable, calibrated caliper was used to measure the graphological spaces in written statements. The psychological inventory results helped explain a portion of writing variations seen. All data were analyzed using IBM SPSS statistics software, for statistical analyses. Friedman's two-way analysis of variance (ANOVA), hierarchical multiple regression analysis, and two-way ANOVA were used to analyze these data.

Definitions

Criteria Based Content Analysis (CBCA): A method for detecting deception in statements, considering the presence of emotion as a sign for veracity (Bogaard et al., 2014).

Deception detection: A field of study devoted to verbal or nonverbal discrepancies in a person's behavior or physiology (Granhag et al., 2015).

Dependent variable: For the purpose of this study, the graphological spacing discrepancies found in handwritten statements, such as inconsistent left margins and inconsistencies between spacing of words and sentences.

Graphological analysis: Synonymous for handwriting analysis.

Graphological discrepancies: Inconsistencies found in an individual's handwriting, such as letter and word spacing, height, or slant.

Handwriting analysis: The study of handwriting with regard to a person's personality, behavior, cognitive functioning, and physical abilities.

Independent variable: For the purpose of this study, truthful or deceptive handwritten statements, psychological inventory scores, and cognitive load.

Leakage: Cues the body gives up during deceptive behavior under increased cognitive load (Jacob et al., 2012).

Psychodiagnostics: The study and evaluation of character, based on behavioral and physiological responses (Stein-Lewinson, 1938).

Psycholinguistic cues: For the purpose of this study, written signals relating to the behavioral and cognitive traits of the writer.

Reality monitoring (RM): The theory that memories based on actual events versus those based on imagined events are distinct on several dimensions (Fuller, Biros, & Delen, 2011).

Scientific Analysis Content (SCAN): A method for detecting deception in statements by defining emotional displays as a veracity tool (Bogaard et al., 2014).

Spacing discrepancies: For the purpose of this study, a space greater than or equal to twice the space immediately prior to or immediately after the noted space.

Spontaneous deceptive writing: For the purpose of this study, writing created under timed conditions without prior knowledge of the writing topic.

Assumptions

Participants' confidentiality was preserved, and their participation was voluntary. There was assumed veracity in the research participants' answers to the background questionnaires. Participants disclosed any known illness or condition possibly affecting their handwriting. If answered untruthfully, the interpreted results may then contain false positives for deceptive cues. There was also the assumption the participants followed instructions to write truthful and deceptive statements to prevent incorrect interpretations for graphological spacing discrepancies.

All writing exercises were based on prerecorded movie clips viewed by all participants. By agreeing to participate in the study, participants should have had no reason to sabotage the experiment by not following directions. Due to stratified sampling, the research results may not be generalizable to all populations. Based on the participants' questionnaire responses, the assumption was the participants were representative of a population, who were considered either knowledgeable or familiar with deception detection techniques.

Scope and Delimitations

Graphological spacing discrepancies were chosen, as potential deception cues because handwriting is brainwriting (Schuetz, 2013). Deception detectors often forego contextual deceptive cues, for behavioral cues (Bond, Howard, Hutchison, & Masip, 2013). Graphological spacing discrepancies, as possible deception cues, were chosen after reviewing samples of written statements from criminal suspects, and noting visible patterns in the graphological spacing. Prior research has combined writers' verbal and lexical skills with spatial orientation, to create writing scores for cognitive impairment (Balestrino et al., 2012). Spatial orientation, as related to spacing discrepancies, was the sole focus for the research.

To prevent diffusion of treatment, all directions and stated time limitations appeared as though randomly assigned (Creswell, 2014). Participants' papers were coded for the writing portion of the experiment. The code was used as an indicator whether the participants were in the control or test group, during testing. Whereas research settings may pose a threat to the external validity for the results of this research, an additional predictor variable, cognitive load, was included to simulate affects, indicative of investigative field situations.

The psychological inventories were restricted to tests, previously found in populations, whom successfully displayed deceptive behavior and unsuccessfully displayed deceptive behavior. The BRIEF[®]-A was used to capture information about participants' executive functioning. Particular attention was paid to the inhibition and working memory scales, as the scales relate to deception. Other considerations for

psychological assessment inventories include the CFI and the UDS. The CFI was designed to assess problem-solving, and the ability to shift cognitive strategies, in response to changing context. The UDS was designed to assess the frequency of moral engagement and unethical work behaviors in participants' deceptive work practices. The logic was, participants comfortable with deceptive practices, may demonstrate significantly fewer graphological discrepancies in their handwriting.

Participants, from a stratified sample, were randomly invited to participate. Random invitations prevent a selection threat to internal validity, while increasing the probability of other participant characteristics, being equally distributed among the stratified groups (Creswell, 2014). Participants were chosen from a Southern Illinois community college, and from small police departments in Southern Illinois and Northwestern Tennessee. Convicted criminals were not chosen for the study, because group testing of incarcerated individuals presents a security risk.

Functional near-infrared spectroscopy (fNIRS) has potential uses for future detection of central nervous system activities, associated with deception (Farah, Hutchinson, Phelps, & Wagner, 2014). Yet, portability, price, and insufficient validation, are current deterrents for fNIRS' use in this deception detection study. Another area, detecting intentions in truth or false statements, was not addressed in this study. The theoretical framework was based on Zuckerman's four-factor model, but few field studies, investigating truthful or deceptive intentions, have been performed (Zuckerman & Driver, 2014). To date, no known cognitive or behavioral countermeasure studies have been performed with these studies. A sound theory, distinguishing past or future events,

is needed prior to deception detection studies, for intentions to progress (Granhag et al., 2015).

The research participants were chosen for either their knowledge or familiarity with deception detection techniques. Convicted criminals were initially considered as participants, to generalize results. Due to potential security risks involved with group testing, incarcerated criminals were not included in the present study. Future research may benefit from the inclusion of incarcerated criminals.

Limitations

By selecting a quasi-experimental design, results are generalizable to field research settings, and unlike simple random sampling, stratified sampling controls for the inclusion of the preferred participant characteristics. Participants' written language, gender, or demographics were not considered limitations when designing the sampling frame. According to previous research, these factors do not affect an individual's handwriting discrepancies (Tang, 2012). The elimination of gender and demographics on test results also eliminates any personal biases of reviewers. Individual writing and grammar skills did not bias results because graphological spacing, not lexical skills, was analyzed for deceptive cues. Limitations in comprehension and recall could bias results. In an effort to address these limitations, participants responded to the pre-test questionnaire whether they had any conditions, illnesses, or injuries preventing or affecting their abilities, to compose handwritten responses.

Incarcerated criminals were not considered as participants for this study, due to the inability to conduct tests in group settings. Because of multiple tests and measures in

the study, time conservation was a factor when recruiting participants. As a result of the research design, testing occurred at one site, and during one-time block, for each participant group. Participants were chosen, based on their familiarity or working knowledge of deception detection techniques, and their availability to be tested in a group, within a single sitting.

Significance

Zuckerman and Driver (2014) recognized the unpredictability of involuntary and unintended cues in behavior was much of the public's interest in nonverbal behavior. Theories, based on Zuckerman and Driver's perspective, continue to frame current research (Granhag et al., 2015). Deception detection methods, using subconscious cognitive receptors are more accurate than methods using conscious cognitive receptors (ten Brinke, Stimson, & Carney, 2014). Preventing conscious deliberation of veracity deters stereotyping and biases, while providing a lens to view nonverbal behaviors, which are meant to be concealed.

Identifying possible deceptive cues in written statements could advance productivity of investigations and decrease false confession rates. In theory, setting up a standardized protocol for screening written statements should provide more concise and reliable leads. Identifying deceptive cues should facilitate specification of veracity within statements. The idea for this original contribution resulted from professional knowledge. Interviews and interrogations sometimes elicit false information, hindering or delaying investigations. Communicative behavioral influences sometimes taint witnesses' and suspects' verbal statements during interviews or interrogations. Conversely, written

statements provide investigators a tangible copy of a person's untainted thoughts, behaviors, and cognitive practices. Applying an investigative method to detect possible deception in written statements, could yield more industrious investigations without addition of revenue or personnel.

Identifying graphological deceptive cues should simplify determining the veracity of written statements. Due to the simplicity of the method, law enforcement personnel would need little training for implementation of the deception detection screening tool. Law enforcement officers' screening for deceptive cues would reinforce efforts, to erase false confessions and weak investigative leads. In an effort to gain the communities' needed support and cooperation with local law enforcement, the effects of this deception detection tool could contribute to effective community policing.

The intent was continued positive social change among law enforcement officers. Criminal investigators' acceptance of an indirect deception detection method may encourage the scientific community, to continue reliability and validity studies of this method. Copious amounts of studies are needed to establish this method as a diagnostic tool, for the field or interrogation room. Advising triers of fact on the strengths and limitations of the method could also produce more educated decisions. Because of more educated decisions, citizens will continue to have protection, and trust among civilians and law enforcement could eventually increase.

Summary

Understanding emotions and behaviors is only one feature of deception detection. Associating these emotions and behaviors to the correct deception cue, is another.

Within Chapter 1, the exploration of studies and theories were introduced, which were meant to simplify the aims of creating an empirically sound graphological deception detection method. Handwriting is not only a nonverbal form of communication, but also an indirect view to subconscious thought and behavior (Morgan et al., 2011). Behavioral, dependent idiosyncrasies of handwriting have not been associated with previously researched, deceptive behavioral cues (Kučera & Havigerová, 2011, McQuaid et al., 2015).

Deception detection is complex, due to the involved social and cognitive developments (Cui et al., 2013; Granhag et al., 2015). The resulting complexity is not in identifying deceptive cues. The problem occurs when deception detectors associate wrong emotions and behaviors, to the perceived cues (Hartwig & Bond, 2011). Previously, emotional influences, in general, have been detected in handwriting (Luria et al., 2014). In this study, further exploration of graphological cues, specifically associated with deception, were proposed.

The four-factor model for deceptive behavior, and theories on behavioral and deceptive behavioral leakages, formed the basis for the theoretical framework (Ekman & Cordaro, 2011; Jacob et al., 2012; Zuckerman et al., 1981; Zuckerman & Driver, 2014). The research questions were presented, with the planned progression, for the exploration of deceptive psycholinguistic cues, cognitive traits, and behavioral traits on graphological discrepancies. Communicative, behavioral influences sometimes taint verbal responses, but nonverbal written statements are a tangible, untainted view into a writer's cognitive thoughts and behaviors. As a result of law enforcement's graphological screening for

deceptive cues, efforts to erase false confessions and weak investigative leads would be reinforced, and possibly lead to positive social changes.

In Chapter 2, the scientific community's approach to psychodiagnostic deception detection methods is addressed. Theoretical propositions and possible research weaknesses, in existing verbal and nonverbal deception detection methods, are introduced. As the theoretical framework was developed, Zuckerman's four assumptions for deceptive behavior, arousal, attempted control, affects associated with deception, and cognitive processing, proved instrumental in the research design and rationale for selection of variables (Zuckerman & Driver, 2014).

Chapter 2: Literature Review

Introduction

Social and cognitive processes complicate deception detection (Cui et al., 2013; Granhag et al., 2015). Researchers have continued to investigate deception detection methods, in an effort to generate more objective approaches to criminal investigations. Verbal and nonverbal communication variations, resulting from cognitive load and emotional influences, have been researched (Lin et al., 2013; Luria et al., 2014). Yet, the possible transfer of psycholinguistic cues, from verbal to written communication, has not been confirmed (Granhag et al., 2015; McQuaid et al., 2015). This quantitative study was designed to explore whether internally-produced, deceptive psycholinguistic cues manifests as graphological discrepancies, depending on the scenario's content and context.

Synopsis of Current Literature

Interviewing suspects and witnesses typically creates the most useful information for criminal investigations (Baskin & Sommers, 2012). Conversely, eyewitness statements are often unreliable, and interrogations sometimes produce false confessions (Koppl & Sacks, 2013). When stakes are high for criminals and expert investigators intervene, the accuracy for detecting deception is typically high. Yet, in recent lie detection experiments, researchers excluded key aspects of what experts precisely do in order to detect deception (Levine, 2014). The key factors ignored were listening to and noting communication's content and context (Levine, 2014). Ekman reiterated the significance of behavioral leakages and deception cues in the leakage hierarchy theory

(Granhag et al., 2015). Behavioral leakages and deception cues are inversely related. The less aware a person is of his or her behavior, the more likely he or she will display behavioral leakages (Granhag et al., 2015).

Researchers in this field remain active, however, sometimes involving functional magnetic resonance imaging (fMRI) to detect deception. The ability to pinpoint particular areas of the brain responsible for types of deception and thereby recognizing deception accurately is still in its infancy (Bublitz & Merkel, 2014). Some researchers state they can detect deception with 88% to 90% accuracy rates with fMRI scans (Raine, 2013). These claims are questionable. Researchers have not identified a single deception neuron (Langleben & Moriarty, 2013). Yet, researchers claim, with the assistance of fMRI, they can reveal a sender's true intentions to deceive, regardless whether the sender's utterances are truthful or deceptive (Volz, Vogeley, Tittgemeyer, von Cramon, & Sutter, 2015).

As a result, deception detection researchers now consider the plasticity of the brain and the effects of content and context on brain responses. Deceit is a complex executive function requiring frontal lobe processing along with connections between other sub regions of the parietal and temporal lobes (Raine, 2013). A recent researcher recognized complex emotional and cognitive behaviors, evoked during *duping delight*, referred to successful deception, error handling and conflict recognition. These complex courses of emotions and behaviors were recognized by using a nontraditional approach, that of indirect markers of deception to veracity recognition (Cui et al., 2013). Considering most other deception researchers draw conclusions about deception from

executive tasks only, these researchers' studies are susceptible to error. The executive system is not the only system involved in deception (Cui et al., 2013). Researchers also suggest the neural responses involved in processing the ability as a successful deceiver may present more accurate brain scan markers, than the neural activity associated with producing a lie (Cui et al., 2013; Volz et al., 2015).

To add relevance to the research problem, studies identifying the importance of cognitive load, as a distinguishing feature in deception detection, were noted. A few reasons exist why lies may be more cognitively demanding than truths. Deceivers, unlike truth tellers, are typically more concerned with checking their performance and the reactions of perceivers (Vrij, Granhag, Mann, & Leal, 2011). Role-playing, suppressing the truth, and introducing lies are also cognitively demanding (Vrij et al., 2011). Comparing the subjects' untruthful and truthful statements, in a controlled setting, and under varying cognitive load conditions, is essential to assessing the effects of cognitive load, on changes in behavior and initiation of deceptive cues.

Changes in writing features related to cognitive load have been investigated with the overall emotional influences of truth or deception in regard to writing traits (Lin et al., 2013; Luria et al., 2014). Whether psycholinguistic factors, identified in previous verbal deception detection studies, appear in handwritten statements is unknown (Granhag et al., 2015; McQuaid et al., 2015). Research studies have not been published after 2010 in which the researchers compare deception in the form of feigned ignorance, classic lies, or misleading information to quantifiable discrepancies in handwriting. Similarly, research studies were not found, in which the handwriting analysis approach was from a

spontaneous and emotionally driven perspective, with quantitative design and analysis. The intent was an exploration for possible cues in spontaneously written deceptive statements, which were often detected in verbal statements. Possible implications for deception were explored from graphological discrepancies and psychological inventory test results.

Chapter Preview

Within this chapter, the existing research is presented, in which the theoretical framework is grounded, based on Zuckerman's four-factor model of behavioral cues to deception (Zuckerman et al., 1981; Zuckerman & Driver, 2014). The rationale for the selection of key variables is based on seminal works of Saudek and Sonneman (Saudek, 1931, 1934; Sonneman, 1953). Recent theoretical propositions, relating to simple lie countermeasures and physiological countermeasures of deception detection, are addressed (Lin et al., 2013; Rosenblum, 2010; Walczyk, Igou, Dixon, & Tcholakian, 2013). The rationale for choosing Downey and Klage's behavioral reaction theories when correlating psychodiagnostics with graphology are presented, (Downey, 1911; Stein-Lewinson, 1938). Saudek and Sonneman's handwriting theories were the basis for the rationale in choosing graphological spacing discrepancies as the key DV (Saudek, 1931, 1934; Sonneman, 1953).

Literature Search Strategy

Limited research has been published, addressing handwriting analysis as a method for deception detection (Tang, 2012). Research on verbal communication and nonverbal microexpressions, dominate the field of deception detection (Granhag et al., 2015; Porter,

ten Brinke, & Wallace, 2012; Vrij & Granhag, 2012; Yan, Wu, Liu, Wang, & Fu, 2013). Handwriting has previously been referred to as brainwriting (Schuetz, 2013). It is likely, through utilization of handwriting in interrogations and interviews, investigators may have a time-stamped view of a person's behavior and emotions, despite conscious efforts of the writer to disguise graphological traits. The following databases and search engines were used in an attempt to investigate cognitive domains and behavioral traits, associated with deception in handwriting: EBSCOhost, Google Scholar, APA PsycNET, Google Books, ProQuest, Wiley Online Library, Science Direct, CrossRef, ACM Digital Library, .gpo, .gov, sagepub.com, heinonline.org, IEEEExplore, PubMed Central, Taylor and Francis + NEJM, link.springer.com, and Open World Cat.

Search terms and combinations of search terms: *deception detection, deception in handwriting, handwriting behaviors, handwriting analyses, truthful and deceptive written statements, graphological detection of deception, graphological spacing discrepancies, forensic interviews, interviews and interrogations, forensic science evidence in law and science, graphology and or handwriting analysis, investigative and forensic psychology, counter-interrogation strategies, cognitive load, cognitive demand, false intentions, false confessions, unanticipated questioning, high cognitive load, verbal and nonverbal communication of deception, correlates of deception, executive function and deception, fMRI and deception detection, statement credibility, measuring cognitive load, cultures of lying, lie detection verbal and nonverbal, nonverbal signals, self-regulation theory, decision control, cognitive load theories, cues to deception, spontaneous deception, measuring deception quantitatively, emotional intelligence, executive functions' influence*

on deception detection, quantifiable discrepancies in handwriting, types of deception, handwriting assessments for adults, measures, neurological issues associated with deception, new deception detection theories, cognitive flexibility, moral disengagement, psychopathy, speech hesitations, and speech pauses in deception

The time frame for the literature review encompasses the last five years of published research and peer-reviewed journal articles, with some seminal works dating to the early 20th century. Sparse current research shadows the controversial role of graphological deception detection studies (Tang, 2012). The focus of recent research has been on the lexical content for written or transcribed statements (Bogaard et al., 2014). The approach for this study was an exploration of psychodiagnostic cues through the examination and analysis of cognitive traits and deceptive behavioral cues relating to possible graphological idiosyncrasies.

Theoretical Foundation

According to Zuckerman's four-factor model, deception involves the following four behavior-influencing factors: arousal, attempted control, affects associated with deception, and cognitive processing (Zuckerman et al., 1981; Zuckerman & Driver, 2014). Emotional responses are automatic and influenced by a person's surroundings (Ekman & Cordaro, 2011). Deception is meant to be concealed. When individuals try to control their behavior, this causes increased cognitive load and the body to give up clues to deceptive behavior, which is known as leakage (Jacob et al., 2012; Zuckerman et al., 1981; Zuckerman & Driver, 2014). When aligned with previous emotional responses and deception theories, handwriting is a nonverbal behavior, expected to present behavioral

leakages (Zuckerman & Driver, 2014). The following sections address recent handwriting studies, along with each component of Zuckerman's four-factor model, supported by more recent studies and theories. Delineations of assumptions and examples for previously applied theories to deception detection preface the rationale for choosing the theories, within which this current research is supported. The theoretical foundation section concludes with possible research challenges.

Theoretical Propositions of Handwriting and the Four-Factor Model of Deception

Schuetz (2013) considers handwriting as brainwriting, because handwriting originates with neural impulses from our subconscious. In principle, handwriting is a permanent snapshot of an individual's emotional state. Therefore, handwriting is a form of nonverbal behavior, conducive to emotional affects (Jacob et al., 2012). When applying Zuckerman's four-factor model to handwriting analysis, the expectation was observed leakages in an individual's handwriting, caused from deceptive behavior (Zuckerman et al., 1981; Zuckerman & Driver, 2014).

Lying causes a person's emotions to change. Sometimes, the change is slight (Zuckerman & Driver, 2014). The expectation was an observed change in handwriting, with triggering of emotions, as a person changes from writing truthful to deceptive statements. When people lie, they try to keep control of their emotions (Zuckerman & Driver, 2014). The supposition was a greater observed left margin indentation, as a writer changes from truthful to deceptive writing. The writers' margin shifting may prove to be a subconscious effort to contain writing in a smaller space, in an attempt to maintain control over their emotions. As our emotions change, so does our handwriting. Some

liars use more deliberate words when describing or recalling information (Granhag et al., 2015). The expectation was a translation into a more deliberate writing style, comprised of closer spaces between letters, as the hand tenses.

Arousal. Behavior is sometimes affected by arousal of emotions, occurring during deception (Zuckerman & Driver, 2014). According to the Yerkes-Dodson Law, apprehension or stress sometimes results in increased performance to a point, then decreases in a parabolic curve (Yerkes & Dodson, 1908). Changes in writing styles and pressure, mimicking a parabolic curve, were expected with an anxious or stressed state (Lin et al., 2013; Tang, 2012). Zuckerman and Driver (2014) noted in a meta-analysis, communication channels may also form a leakage hierarchy. The majority of leakages occurred within the behaviors for which the deceivers were least aware (Zuckerman & Driver, 2014).

Deceivers' observations should follow the Yerkes-Dodson Law, suggesting behavioral self-awareness decreases, with familiarity of an existing stressed or anxious state. The participants' handwriting was expected to mimic these differences in speech and presentation. Deception increases an individual's cognitive load, as the person tries not to discredit him or herself (Zuckerman & Driver, 2014). The supposition was an increase in space width between sentences or words, as the lying individual pauses, to reorganize or remember truthful thoughts (Lin et al., 2013). Considering handwriting is a snapshot of a person's emotions, the focus was an analysis of the possible behavioral associations to written deceptive cues (Schuetz, 2013).

Attempted control. The interpersonal deception theory (IDT) and the four-factor model, view verbal and nonverbal interactions between deceivers and observers, as potential opportunities for leakage of the deceiver's behavior (Dunbar et al., 2012). A target's observation of a liar initiates an interaction. Therefore, the liar and target mutually influence each other, making the content and context of interviews central to the interaction (Vrij & Granhag, 2012). The content and context, surrounding and contributing to the subject's written statements, was hypothesized to influence the subject's handwriting. When considering veracity, liars are usually more concerned about the impressions they make on others. Ironically, truth tellers' lack of concern, or too much concern, can seem suspicious (Granhag et al., 2015).

The self-presentation theory, once thought to address cognitive phases occurring only during nonverbal behavior, has recently been found applicable to deception detection (DePaulo & Bond, 2012). Researchers suggest a liar's intent to regulate and to present behavior depends on the extent of deception, for previous referenced actions (DePaulo & Bond, 2012). For example, more intense deceptive cues occurred when the lies referenced actions, identities, or other offenses, as opposed to thoughts and opinions (DePaulo & Bond, 2012). Nevertheless, control of behavior is not possible, if a person is unaware of fluctuations in conduct. The result is behavioral leakage (Granhag et al., 2015). The hypothesis, subjects are less likely to notice behavioral changes during spontaneous lies, compared to rehearsed lies, was explored. Unlike brief fleeting microexpressions, graphological leakages are a permanent recording of the subject's behavior.

Affects associated with deception. People usually believe others, but this presumption of honesty is adaptive. Dishonest messages typically contain deceptive intent or evoke awareness of deceit. Most deception theories are based on the conduct and elicited nonverbal cues from potential liars (Levine, 2014). Conversely, the truth default theory is focused on the communication's context of the content (Levine, 2014). As previously mentioned, the deceiver and observer mutually influence each other (Vrij & Granhag, 2012). Correspondences are possibly diagnostic. Levine (2014) considers the key to expert deception detection, prompting of diagnostically useful information, rather than detecting and recovering passive nonverbal communication. Deceptive statements are not created for goals, unique to honesty or deception. The deceiver creates deceptive statements, when aligning with the observer's expected goal (Levine, 2014). This is why, emphasis was placed on the participants' goals to convince the reader they were writing truthful statements, even when instructed to write deceptive statements.

Researchers proposed, according to the conflict and punishment theories, increased autonomic responsivity results from the liar's internal conflicts between telling truths and lies, and the individual's chances for discovery (Zuckerman & Driver, 2014). According to the conditioned response theory, answers to concealed information are compared to those of conditioned stimuli. Similarly, some answers to the Guilty Knowledge Test were a result of the individuals' increased autonomic responsivity, due to arousal (Zuckerman & Driver, 2014). The differentiations, made between orienting and defensive autonomic responses, explained similarities and differences in autonomic responses, to lying and concealment of information (Elaad, 2015).

According to Sokolov's orienting response theory, people orient and carefully respond to environmental stimuli, novel or emotionally significant to them (Walczyk et al., 2013). Several experiments have been important in supporting orienting responses, yielding decreased heart rates, as the underlying mechanism to masking information. In addition, Verschuere reminds deception experts of the response inhibition theory, accountable for arousal suppression, which often follows the orienting response (Elaad, 2015). Consequently, the deceiver's intent to suppress arousal often intensifies behavioral cues, which is why future lie detection research will focus on suspects' tendencies to seclude, rather than orient themselves toward crime details (Elaad, 2015).

Following Zuckerman's four-factor model, the expectations were observation of similar graphological discrepancies, when referencing the motivation to deceive and the intent to conceal. Ekman coined duping delight to mean the joy associated with successfully deceiving. Ekman explained the emotion as the essence for a group of psychological states, rather than a single emotion, subconsciously expressed (Ekman & Cordaro, 2011). Zuckerman saw this behavioral response to deception as a direct reflection of particular affects, associated with deception, rather than an outcome of emotional arousal (Zuckerman & Driver, 2014). Although, high stakes deception is typically emotional, multiple opportunities to rehearse or deceive can create malleable emotional responses (Hu, Chen, & Fu, 2012). In these instances, fewer graphological discrepancies were expected, justifying the need for indirect questioning and unsuspecting questions, from a spatial and temporal perspective (Vrij et al., 2011). Handwriting was analyzed from spontaneous and rehearsed lies, with scaled cognitive

and behavioral profiles to identify any behavioral traits, which might prove to be more prevalent during certain types of deception.

Cognitive processing. Some deceptive behavioral cues may have multiple causes. Discovering an exact causal precursor for deception detection is inconceivable, even when the context is understood (Zuckerman & Driver, 2014). Prior researchers proposed lying is more difficult than truth-telling (Zuckerman & Driver, 2014). Lying may result in many different speech characteristics, such as longer speech latencies, more hesitations, shorter responses, increased irrelevant information, and fewer nonverbal illustrators (Zuckerman & Driver, 2014). Creating lies is more cognitively demanding than concealing lies, but good actors and more intelligent people find lying easy (Vrij et al., 2011). Following Zuckerman's and Vrij's theories, cognitive traits were investigated to discover whether the traits are more or less conducive to graphological discrepancies, in written lies.

A liar's character and circumstances, under which they lie, affects how they try to control their behavior, reactions, and cognitive efforts, while concealing or creating lies (Vrij et al., 2011; Zuckerman et al., 1981). Walczyk's information manipulation theory-2 (IMT2) disagrees with Zuckerman's four-factor model, deception is more cognitive load inducing than honesty (Walczyk, 2014). The cooperative principle of expectations between two converses, is the basis for the IMT2. Walczyk (2014) sees deception as a violation of one or more conversational maxims, such as the quality, the quantity, the relevance, and the manner.

Walczyk (2014) argues deception is an efficient solution, because deceiving reduces cognitive load, and the liar's motivation is proportional to the differences between costs and benefits. Walczyk (2014) proposes most lies to be spontaneous and arising from largely subconscious processes, excluding high-stakes lies. Laboratory experiments cannot reproduce high stakes lies, because the lack of complete spontaneity and the possibility for emotional stresses involved, exists. If cognitive load can be induced and spontaneity included, simulating similar cognitive traits seen in high-stakes lies, then the possibility exists the results can be generalized to cases in the field.

Delineations of Assumptions

Deception's multiple cognitive courses continue to complicate defining the neural networks, unique to deception. The chance remains, even after identifying neural networks, the effects of simple countermeasures, used by liars to defeat lie detection procedures, will remain indistinguishable (Abe & Greene, 2014). The National Research Council opposes the use of the Controlled Question Technique (CQT), used in polygraph examinations, because CQT lacks standardized methods and is prone to countermeasures (Walczyk et al., 2013). Cognitive load-inducing techniques, not susceptible to lie rehearsal or physiological countermeasures, could possibly improve the CQT (Walczyk et al., 2013).

The invalid assumption, lying causes more sympathetic nervous system arousal than truth-telling, justifies successful countermeasures by those, subjected to the polygraph and fMRI for deception detection (Walczyk et al., 2013). The sympathetic nervous system reacts to stressors on the body. Damasio states in the somatic marker

hypothesis good decisions are made by listening to the body, such as increased heart rates and sweating (Raine, 2013). Damasio's hypothesis was used, while studying successful and unsuccessful psychopaths (Raine, 2013). In Damasio's finding, successful psychopaths had lower resting heart rates than unsuccessful psychopaths and control participants. Both the control participants and the successful psychopaths made good decisions, based on the awareness of their bodies' somatic markers. These markers were interpreted as warning bells for the successful psychopaths to avoid circumstances, similar to previous conditions with negative results (Raine, 2013).

Examples of Previously Applied Theories to Deception Detection

ten Brinke, MacDonald, Porter, and O'Connor (2012) promoted a multiple-cue approach to deception detection. Unlike many other deception studies, ten Brinke et al. (2012) used videos of high-stakes lies, analyzing pleader sincerity. Although a passive approach, the researchers correctly classified credibility in 90% of cases. Behavioral differences, between genuinely distressed and deceptive subjects, were noted when viewers compared pleaders' tentative word use and emotional cues. Following Zuckerman's four-factor model, ten Brinke et al. (2012) analyzed attempted control, arousal, and display of emotions with veracity judgments, yet the researchers did not address cognitive processing. The subjects were neither asked questions nor were the subjects asked to deny offenses.

In a recent study, linguistic cues in written statements were used to judge veracity of the statements. The researchers based their research design on previous studies, claiming verbal cues were more accurate than nonverbal cues in detecting deception. The

researchers tried to passively analyze verbal cues as linguistic cues, without the aid of nonverbal cues (Masip et al., 2012). The researchers hypothesized, participants choosing effective veracity cues would have higher rates of success. The researchers used a linguistic inquiry and word count (LIWC) program to examine the language for psychological variables, possibly linked to deception. Based on the findings, the researchers suggested the participants were either not using deception cues or using them unsatisfactorily (Masip et al., 2012). The overall accuracy rate for veracity detection was no better than chance. In the referenced study, the researchers used the LIWC with different types of subjects and varying context, so future research should focus on similar subjects and consistent context, for better generalizability (Masip et al., 2012). The focus for this research was possible psychodiagnostic deceptive cues, found in graphological discrepancies. The intent was an explanation of attempted behavioral control, behavioral affects, and cognitive processing, associated with deception.

Rationale for Theory Choice

Earlier nonverbal communication studies have possible correlating ideas to the psychodiagnostics of graphological analyses. For example, motor skills are secondary to sensory skills, so our brains process behavioral reactions before sending messages to our hands to begin writing (Downey, 1911). Researchers, noting similar handwriting within families, educational experiences, and social influences drew attention to the possibility, subconscious imitation and cognitive behavioral influences may also occur in handwriting (Downey, 1911). Therefore, a guiding personal image likely precedes every intentional movement, as proposed by Klages (Stein-Lewinson, 1938).

Pennebaker's lifework has been focusing on people's writing content (Pennebaker, 2011). After studying patients' handwriting while they recovered from traumatic experiences, Pennebaker (2011) began noticing changes in the patients' pronoun use, as the patients' health improved. After further studies, Pennebaker (2011) noted people's brains process function words, such as that or my, differently from content words, such as man or computer. Comparing writing from genders, social classes, education levels, and emotional states, granted Pennebaker (2011) the opportunity to see sociological and psychological behavioral influences, presented in written language.

Downey's 1910-1911 literature review of publications focused on articles, utilizing handwriting diagnostically, and for evidential purposes. Previous researchers noted refinement of methods for studying handwriting may, in time, justify graphology's use as a diagnostic method (Downey, 1911). For Klages, handwriting reflected the writer's entire personality (Stein-Lewinson, 1938). Klage's interpretation of handwriting was psychodiagnostic, reflecting the writer's intellect, emotions, and physical tendencies (Stein-Lewinson, 1938). In turn, Klages rejected graphology, as an interpretation of isolated signs and viewed handwriting as a combination of traits (Stein-Lewinson, 1938). This explanation of handwriting sparked the search for a theory, explaining both subconscious and conscious contributions to handwriting discrepancies. Zuckerman's four-factor model was chosen, because Zuckerman recognized both behavior- and cognitive-influencing traits in deception (Zuckerman & Driver, 2014).

Theory and Research Study Relationship

In 1929, Saudek claimed to have isolated 12 cooperating traits of handwriting, which combine to form simple idiosyncrasies in handwriting (Saudek, 1931). Saudek believed these idiosyncrasies were chief, when analyzing written documents, because he believed a writer could not concentrate on both, the subject matter and the handwriting (Saudek, 1931, 1934). Sonneman combined Klages' theory of movement and Angyal's theory of personality to describe handwriting, as the balance between communications' content and context (Sonneman, 1953). After studying these theories, Sonneman determined spontaneously produced writing was of greater psychodiagnostic value than copied writing (Sonneman, 1953). In the results, Sonneman did not explain the importance of handwriting's sensitivity to movement, seen under the pressures of current content and context association (Bell, 1951).

Researchers in the early part of the 20th century defined handwriting as brainwriting, because the brain controls initiation and engagement of handwriting (Schuetz, 2013). Researchers viewed handwriting, as a snapshot of the writer's behavioral expressions, during a specific time. Instead of continuing psychodiagnostic research, started in the early 1900's, graphologists became enamored with possible personality and handwriting correlations. Most present-day graphologists do not have an education in psychology, nor have these graphologists studied the theoretical foundations, associated with personality and handwriting's dependent idiosyncrasies (Kučera & Havigerová, 2011). The research intent was a psychodiagnostic approach to behavioral influences and individuals' writing idiosyncrasies on deception detection cues.

Research Questions Related to Research Challenges

Based on the findings during the literature search, the following research challenges appear as possibilities. In Research Question 4, the question was stated whether spontaneously, versus non-spontaneously produced deceptive writing exhibits variances, in graphological spacing. Spontaneity's psychodiagnostic value is prime, considering most lies are spontaneous (Walczyk, 2014). Certain behavioral graphological cues may be dependent on the content and context of the statement. Nevertheless, field settings cannot always be recreated in laboratory settings, where the relationship between content and context are spontaneous and cognitively stimulating. This could present a challenge for generalizing the results.

In Research Question 5, the question was stated whether participants' scores for moral disengagement and unethical work behavior, as measured by the UDS, correlate with graphological spacing discrepancies. An ethical predisposition is only one of several links to moral reasoning. Cognitive moral development and contextual factors, such as ethical climate and culture, impact a person's choice and timing about moral disengagement (Barsky, 2011). According to Bandura (1999), people separate from moral supports and act in deviant ways through cognitive rationalizations. Initially, the thought was, the more complex a person's cognitive moral development was, the less susceptible the person would be to external influences (Barsky, 2011). In recent research, a person's increased cognitive capacity was hypothesized to increase the person's ability for more sophisticated rationalizations, for deviant behavior (Hystad, Mearns, & Eid, 2014; Martin, Kish-Gephart, & Detert, 2014). The participant groups chosen for the

current research may not be conducive to exploring these latest findings, but future research, comparing white-collar criminals with repeat offenders, will be considered.

In Research Question 6, the question was stated whether written statements void of personal memories show increased graphological discrepancies. Vytal conducted the first experiment, directly comparing apprehension, working memory performance, and cognitive load (Vytal, Cornwell, Letkiewicz, Arkin, & Grillon, 2013). Vytal highlighted the importance of considering cognitive load when studying emotion-cognition interactions (Vytal et al., 2013). Apprehension, under low cognitive load, hinders verbal working memory, and apprehension, under all levels of cognitive load, hinders spatial working memory (Vytal et al., 2013). Based on these findings, the expected outcome was graphological spacing discrepancies may occur in participants with personal memories and any level of cognitive load. If this should occur, the expectation was participants' handwriting with personal memories and cognitive load, to have fewer graphological spacing discrepancies than participants' handwriting, with no personal memories and cognitive load.

In Research Question 7, the question was stated whether participants' scores on the Working Memory and Inhibit domains, measured by the BRIEF®-A, correlate with participants' graphological spacing discrepancies. Researchers suggested a lifelong pattern of negative aggressive behavior correlates with impaired verbal working memory (De Brito, Viding, Kumari, Blackwood, & Hodgins, 2013). The researchers analyzed offenders with executive functioning difficulties. The offenders were diagnosed with both or one of each, antisocial personality disorder and psychopathy (De Brito et al.,

2013). Based on the above correlation, the expected outcome was, if the research participants displayed impaired working memory, they could possibly display similar writing discrepancies, indicative of deceptive behavior. Considerations for prior or existing injuries, illnesses, or conditions affecting participants' memory, were made when compiling questions for the screening questionnaire, and when reviewing the cognitive domain results.

Literature Review Related to Key Variables

Research with the potential to unmask deceptive cues through behavioral leakages was included in the following literature review. Psycholinguistic cues in truthful and deceptive written statements, cognitive domains, behavioral traits, and memory-induced and spontaneous lies were also included in the literature review. According to Zuckerman's four-factor model, attempted control, emotional arousal, emotional display of deception, and cognitive processing are behavior-influencing factors, playing vital roles in deceptive behavior (Zuckerman et al., 1981; Zuckerman & Driver, 2014). Subtle and short-lived cues were identified as making deception detection difficult (Masip et al., 2012). Subconsciously-created cues were searched, which were not previously identified and quantified as deceptive cues. The cues were graphological spacing discrepancies in left margins, spacing between words, and spacing between sentences. Investigative handwriting was chosen for possible associations with spacing discrepancies, and Zuckerman's behavior-influencing factors, as the two relate to psychological traits and deceptive behaviors. Cognitive domains and behavioral traits were explored as they possibly relate to handwritten deceptive cues.

There was limited research on the transference of psycholinguistic cues to handwriting. Investigations ensued to uncover what may be comparable cues in speech. Following suit, pauses in speech, often induced by cognitive load, are viewed comparable to graphological spacing discrepancies in handwritten statements (Lin et al., 2013). Because the brain controls both speech and handwriting, behavioral leakages are expected to occur in both (Lin et al., 2013; Luria et al., 2014; Zuckerman & Driver, 2014). If so, behavioral leakages are expected to manifest as graphological spacing discrepancies in handwritten statements.

Related Studies Consistent with Scope of Study

Consistent with exploring various cues for deceptive or truthful behavior, related IVs were investigated. The similar relationships of these IVs to the study's DV, graphological spacing, was discussed. The subsequent IVs were discussed successively, truthful and deceptive outputs, spontaneous lies, memory-induced lies, and cognitive and executive functioning traits.

McCornack frames deception as covert multidimensional manipulation of information, according to the information manipulation theory 2 (IMT2). Researchers focus on the efficient and swift contextual problem-solving characteristics of the IMT2 (McCornack, Morrison, Paik, Wisner, & Zhu, 2014). The central premise for IMT2 is five-pronged. For the first prong, McCornack et al. (2014) posit deception and truth verbal outputs are neurologically the same, which is justification for why fMRI deception detection is considered flawed (Ganis & Rosenfeld, 2011).

For the second prong, the researchers posit speech generated between truths and lies incorporate parallel cognitive processing (McCornack et al., 2014). Most deception models are top-down, linear-sequential accounts of discourse production. Walczyk (2014) does not agree the different degrees and types of deception are accurately represented when presented in this manner. Similarly, researchers have not identified the levels and types of deception in IMT2 (McCornack et al., 2014). Researchers, using IMT2, have illustrated people do not initially make conscious decisions to lie, prior to beginning a discourse (McCornack et al., 2014). In both the IMT2 and Walczyk's activation decision construction action theory (ADCAT), researchers assert deception typically arises spontaneously in normal conversation. Conversely, Walczyk contends high stakes lies are more likely to use top-down linear-sequential planning, which is more applicable to deception detection in criminal investigations (McCornack et al., 2014; Walczyk, 2014).

For the third prong, McCornack et al. (2014) concur with the premise, lies result from the need for quick solutions drawn from available information. Accordingly, cognitive processing should be rooted in the studies of memory and problem-solving (McCornack et al., 2014). Previous researchers advance cognitive load, imparted by lying versus truth-telling, is partly due to the initial activation of the dominant truth response, because our brains process truths easier than lies (Debey, De Houwer, & Verschuere, 2014). In the working model of deception, researchers point to the usefulness for truth in the lying process. Lie construction requires both truth and false responses in the working memory, in order to shift between the two during responses

(Debey et al., 2014). Working memory seems to be the most logical location for easily-available information, needed for quick problem-solving (McCornack et al., 2014). McCornack's reasoning, lies result from the need for quick solutions, adds further support for the hypothesis, spontaneous versus rehearsed lies will present more graphological spacing discrepancies, due to the lack of both truthful and false responses in the working memory.

For the fourth prong, McCornack et al. (2014) state consciousness is not a continual flow of information. Rather, there is instead brief snippets of focused attention. The global workspace theory's (GWT) modular views, of cognition and current knowledge for brain functioning, are the foundation for this fourth prong (Franklin, Madl, D'Mello, & Snider, 2014). The idea, graphological spacing could vary within sentences, should follow the GWT of cognitive processing, when applied to the toggling of truth and deceptive statements. As previously noted, lie construction requires both truth and false responses in the working memory for quick recall of information (Debey et al., 2014).

For the last prong, McCornack et al. (2014) posit mid-utterance modifications of dialogue are normal. People's perceptions change during cognitive processing (McCornack et al., 2014). Considering this prong, *hmms* and *ughs* within speech, are cues signaling the transition of current thought processes. In following McCornack's thought processes for each prong of this theory, the hypothesis was, these transitions may also translate to variations in graphological left margin spacing, spacing between words, and spacing between sentences. These transitions may, or may not be indicative of an

upcoming change in the writer's veracity. The scores from the psychological inventories and baseline writing samples assisted in explaining these variances.

Previous Research Approaches to Key Variables

Memories. Reality Monitoring (RM), initially introduced as a model for determining the veracity of memories, has been developed into a deception detection method. Transcribed statements are analyzed for memories, produced internally or externally. Memories, apprehended by the senses, are found more often in truthful statements, versus memories given meaning through cognition and emotion (Willén & Strömwall, 2012). If written statements are a combination of conscious expressions for communications and subconscious thought, then perhaps, the written statements can be analyzed for graphological idiosyncrasies. Whether a person's memories are based on their senses or emotions, may also affect the possibility for graphological idiosyncrasies.

Cognitive load and hesitations. Goldman-Eisler investigated the purpose of hesitation pauses in speech. As a result of the statistically sound results, Goldman-Eisler (1958) confirmed speech breaks function to anticipate increases in information. Goldman-Eisler's predecessors concluded speech verbalization occurs in duplicate. The thought is subjectively considered and then objectively communicated (Goldman-Eisler, 1958). Therefore, words exerting less cognitive load are verbalized, almost automatically without significant pauses. As a result of research, Goldman-Eisler (1958) indicated words following breaks were longer lengthwise, and these words were content words. The words preceding the pauses were structural words, and shorter in length (Goldman-Eisler, 1958). For the current study, possible relationships between cognitive load and

spontaneity of lies, to the variances in graphological spacing discrepancies, were investigated.

Planned versus spontaneous statements. Kirchhübel and Howard (2013) attempted to use speech cues, specifically speech frequencies to detect deception. These researchers quickly realized varying speakers' speech idiosyncrasies individualized the speakers' individual behavior (Kirchhübel & Howard, 2013). Deception detection is multifaceted. Kirchhübel and Howard (2013) found, defining specific cues and recording determinant results, to be impossible. Speakers develop different speaking styles, dependent on content and context (Kirchhübel & Howard, 2013). In the current study, an exploration occurred of graphological spacing, dependent on content and context of written statements. One possible problem with Kirchhübel and Howard's (2013) methodology was, the subjects were told in advance, which sections of the interview were, either for truth-telling or for lying. The lack of spontaneity may have contributed to the insignificant differences in frequency between the truths and lies.

Individual idiosyncrasies. Kirchhübel and Howard (2013) advanced three of Zuckerman's behavior influencing factors as possible models of deceptive behavior. Kirchhübel and Howard were displeased with the expected differences between liars and truth-tellers, based on acoustic and phonetic speech parameters (Kirchhübel & Howard, 2013). After reviewing Kirchhübel and Howard's (2013) results, the researchers' lack of consideration for the subjects' personality and the context when analyzing the results, was apparent. Perhaps, this explains why contradictory results appeared across, and within speech parameters (Kirchhübel & Howard, 2013). Had Kirchhübel and Howard

understood the subjects' varying idiosyncrasies, the researchers should have realized, not all three behavior influencing factors searched were applicable to every subject in every case.

Baseline and control samples. As a result of pauses, intentional and unintentional communicative messages are conveyed. Researchers have been inspired to carry on discussions, relating to speech interruptions, and the interruptions' signaling abilities (DePaulo, & Bond, 2012). Researchers continue to support the idea liars monitor their speech more aggressively than truth tellers. Liars exhibit overall fewer pauses in their speech, even during spontaneous questioning (Ulatowska, 2013). Due to the multifaceted cues of deception, speaker-dependent lexical habits continue to prove helpful, to observers when detecting deception in speech (Ulatowska, 2013). The expectation was, this also would be true when analyzing handwriting. In addition to content and context, Ulatowska (2013) reiterates the significance of obtaining control and baseline graphological samples, for comparison of a subject's behavioral characteristics.

Rationale for Selection of Variables

Some behavioral correlates of deception have more than one cause (Zuckerman & Driver, 2014). For this reason, both Saudek's and Sonneman's perspectives of handwriting analysis were closely followed. A writer cannot concentrate, both on the subject matter and handwriting (Saudek, 1931). Therefore, a reasonable assumption is, graphological behavioral leakages are a possibility.

Content and context. Based on theories of movement and personality, Sonneman posited handwriting is a balance between the writer's communicative content

and the context, under which a statement is written (Bell, 1951). An unpremeditated written account is a record of the person's thoughts and emotions. For this study, the IVs are defined as truthful or deceptive written statements, scores from specific cognitive and behavioral domains, and cognitive load placed on the participants, while writing their statements. The DV was defined as discrepancies, found in handwritten statements, such as inconsistent left margins and inconsistencies between spacing of words and sentences.

Lack of performance appraisal. Besides Zuckerman's four-factor model, researchers have considered the self-presentation theory and IDT, when addressing leakage of nonverbal cues to deception (DePaulo & Bond, 2012; Dunbar et al., 2012; Zuckerman & Driver, 2014). According to these theories, leakage of cues can accompany a liar's orchestrated behavior, thus signaling deception. Intended and regulated behavior is often translated into non-verbal behaviors, without awareness by the host individual. Through responses and reactions, receivers provide performance appraisal for the individual (DePaulo & Bond, 2012). The lack of performance evaluation, such as the case in a written statement, will perhaps, make an individual more vigilant in choosing responses. As a result, more constrained writing may occur.

Working memory and executive functioning. According to the working memory model of deception, researchers conveyed telling lies required greater cognitive load when compared to truth-telling, because less personal memories were available on which to rely (Alloway, McCallum, Alloway, & Hoicka, 2015). As a result of recent research with children, researchers suggest verbal working memory plays a role in processing and manipulating the multiple pieces of information, involved in lie-telling

(Alloway et al., 2015). Good liars outperformed bad liars on processing and recall of the verbal working memory test (Alloway et al., 2015). The presence of working memories is not the only factor to be considered, when calculating the effects of working memory on cognitive load.

Different degrees and types of deception. When referring to the IMT2, Walczyk discredits the view, deception is always more cognitive load inducing than honesty (Walczyk, 2014). The different degrees and types of deception are fundamental to the lying process. During normal conversation, deception typically arises spontaneously. Working memory houses rehearsed lies, so less cognitive load is exerted (Vrij et al., 2011). High stakes lies usually involve top-down, cognitively demanding, sequential accounts (Walczyk, 2014).

Concealing deception. The orienting response theory is especially applicable to concealment of deception. Individuals tend to orient and carefully align themselves to novel or emotionally significant stimuli (Walczyk et al., 2013). The orienting response to guilty knowledge is hypothesized to be automatic and difficult to suppress (Walczyk et al., 2013). As a result of the orienting response, greater graphological spacing may occur. A writer's attempt to distance themselves from the reader or redirect the reader's attention may become difficult while suppressing or concealing deception.

Suppressed memories. According to the preoccupation model of secrecy (PMS), memory processes, response selection, response preparation, and motor execution, are involved in deceptive and truthful responses (Walczyk et al., 2013). Referring to PMS, researchers explain the cyclical path occurrence, with guilty knowledge. The suppressed

memories become recurring memories, when the individual intently tries to suppress them. As a result, the guilty knowledge activates the orienting response, an automatic and hard to suppress behavior (Walczyk et al., 2013).

Studies Related to Key Variables

Truthful and deceptive statements. In the mid-1980's, a former Israeli polygraph examiner, Sapir, developed the SCAN method (Bogaard et al., 2014). A recent study, using sexual abuse statements, found SCAN lacking in a standardized coding system, well-defined criteria, and low inter-rater reliability, except for two criteria (Bogaard et al., 2014). Unlike CBCA and RM, researchers identify the location of emotion words, within the written statement as significantly important, following SCAN requirements. CBCA and RM find the presence of emotions in written statements, indicative for authenticity, regardless of placement (Bogaard et al., 2014).

In a 2012 study, researchers compared SCAN and RM. The researchers found RM to discriminate significantly between truth and lies (Nahari et al., 2012). Masip et al. (2012) doubt the generalizability of non-verbal studies to written truths and lies. Nevertheless, the researchers did not mention the generalizability of verbal studies to written deception detection (Masip et al., 2012). Instead, the researchers' concern was whether readers would base their veracity judgments on inaccurate deception cues (Masip et al., 2012).

In an effort to prevent questionable veracity judgments, researchers looked to computer programs, such as LIWC, General Architecture of Text Education (GATE), and Agent99-Analyzer (Chung & Pennebaker, 2014; Hauch, Blandón-Gitlin, Masip &

Sporer, 2012). In 2 out of 5 studies testing LIWC, performance was found to be no better than chance (Almela et al., 2013). Researchers concluded verbal cues did not translate to written cues (Hauch et al., 2012). Almela et al. (2013) were not so eager to discount the ability to detect deceit in written statements. They noted a possible pitfall of previous researchers. Most researchers assume everyone lies the same. The individual's deceptive language is rarely compared to a control text, such as a truthful statement (Almela et al., 2013). The LIWC was used to analyze the written statements in Almela et al.'s (2013) study, but the deceptive language produced was not spontaneous, another pitfall of researchers.

Graphological spacing discrepancies. After an extensive search for studies analyzing graphological spacing discrepancies, one article was found with similar ideas to the current research. Haveripeth (2013) was more concerned with internal writing habits and their effects on writing idiosyncrasies, than appearances of handwriting. Haveripeth (2013) posited writing traits become engrained. Regardless of the effort taken to disguise one's writing, idiosyncrasies within the writing will always betray the writer (Haveripeth, 2013). Graphological spacing is a possible deceptive cue, considering word and letter spacing is primarily subconscious behavioral responses to the content or context, surrounding the writer's written statement (Tang, 2012).

Executive functions' influence on deception. While research is limited, comparing executive functions' influence on deception, Ruffman, Murray, Halberstadt, and Vater (2012) found veracity easier to discern in verbal deception studies, involving older adults, rather than studies involving younger adults. The researchers' results

correlated with earlier researchers, reporting difficulties in older adults' social understanding (Ruffman et al., 2012). The researchers indicated older adults have difficulty deceiving others, along with difficulty in recognizing deception (Ruffman et al., 2012). Ruffman et al. (2012) hypothesized the executive functioning trait, emotional recognition, was the culprit responsible for the older adults' difficulties in detecting lies. Working memory was not considered in the above study.

In a second study, researchers conducted an experiment observing minors, 8 to 16 years (Evans & Lee, 2011). The researchers noted relationships between working memory and making deceptive verbal statements. No relationships were found between inhibitory control skills and decision-making, to lie or not to lie (Evans & Lee, 2011). To date, studies comparing adult executive functioning skills, working memory and inhibitory control, to deception in handwriting, have not been found.

Known and unknown conclusions regarding research variables. Writers display noticeable differences in graphology, as observed when comparing truthful and deceptive written statements (Tang, 2012). As a person tries to conceal their lies, they unconsciously change their handwriting. A truthful person's handwriting flows with a distinct rightward slant (Tang, 2012). Handwriting reflects a person's emotions and feelings at the time of the handwritten statement (Tang, 2012). How fluctuations in content or context of the lie will affect the person's handwriting, is unknown. Whether discrepancies in graphological spacing will signal all types of deception, is also unknown. To date, there are no published research studies, where researchers explore possible relationships between deceptive written statements and changes in graphological spacing.

Studies Related to Research Questions

Due to the uniqueness of the topic, most published deception detection studies and graphological studies are indirectly related to the research questions. In a study on beginner writers, researchers determined if a writer's handwriting mechanics was automatic, then cognitive demands could be directed toward higher level processes (Berninger et al., 1997). A duplicate study has not been performed on adults. Either cognitive demands or contextual changes, or both, were hypothesized to possibly yield quantifiable graphological idiosyncrasies.

In another study, Masip et al. (2012) posited focusing on word types, such as functioning or descriptive for deceptive cues in written statements, was not enough to achieve needed deception detection accuracy. Behavioral or personality cues were not considered in the study. Anxiety affects verbal and spatial working memory (Vytal et al., 2013). This type of breakthrough is where cognitive neuroscience deception detection studies need to progress. Vytal et al. (2013) reported anxiety effects may be instrumental in explaining deception detection accuracy rates, in verbal and written detection techniques. Abe and Greene (2014) posited the brain shapes deceptive behaviors due to multiple involved cognitive processes, but distinct neural networks relating to deception are still unknown.

Summary and Conclusions

Handwriting is considered brainwriting, beginning with neural impulses from our subconscious (Schuetz, 2013). Therefore, handwriting is a permanent snapshot of an individual's emotional state. Considering Zuckerman's four-factor model to the

application of handwriting analysis to deception detection, the expectation was observed leakages in an individual's graphological movement, caused by deceptive behavior. Lying causes a person's emotions to change, and sometimes the change is slight (Zuckerman & Driver, 2014). The assumption was detectable graphological changes as a person's emotions change, such as transitioning from writing truthful to writing deceptive statements. When people lie, they try to maintain control of their emotions, by keeping close false emotions (Zuckerman & Driver, 2014). Accordingly, the intention was exploration of quantifiable changes in graphological spacing, reflecting these emotional changes.

Pennebaker's life's work has been focusing on people's writing content. The more Pennebaker analyzed words, the more certain patterns kept recurring. Pennebaker has seen substantial differences in language style, as a function of people's age, emotional state, social class, personality, honesty, leadership ability, and quality of relationships (Pennebaker, 2011). Lexical studies and research applying these findings to computerized graphological analyses, have been performed with veracity judgments less than chance (Chung & Pennebaker, 2014). Memories, apprehended by the senses, are found more often in truthful statements versus memories given meaning through cognition and emotion (Willén & Strömwall, 2012). Written statements are a combination of conscious expressions for communications and subconscious thought (Schuetz, 2013). Considering what is known about written statements and memories, the possibility exists for analyzing idiosyncrasies in written statements, when determining veracity.

There is published research on deception detection in verbal communication, but published research for identifying and quantifying handwritten deceptive cues was not found. Previous studies, on verbal deception and effects of cognitive load on verbal statements, have been performed. Yet, whether psycholinguistic factors carryover into handwritten statements is unknown (Granhag et al., 2015; McQuaid et al., 2015). Handwriting is directed by the brain. Handwriting is an indirect way to map the internal state of a human being (Gupta & Prasad, 2014). Therefore, whether a writer's personality and emotions will appear as behavioral cues, despite conscious efforts to conceal or disguise the writer's graphological traits, is plausible. Changes in writing features, as they relate to cognitive load and behavioral influences, have been investigated (Lin et al., 2013; Luria et al., 2014). Yet, none of the researchers, from the aforementioned studies, approached the spontaneity and emotionally driven aspects of handwriting from a quantitative perspective.

With the research design, the approach afforded the determination of the effects for deception, if any, on spontaneously, cognitively demanding, and emotionally driven determinants of graphological discrepancies, from a quantitative perspective. The effects of truthful or deceptive written statements, and cognitive load, were analyzed by measurable discrepancies, in graphological spacing of handwritten statements. Particular executive functions and behavioral characteristics were also compared to graphological discrepancies, to investigate deception's possible influence on combined cognitive efforts and attempted behavioral control. In order to explore these gaps in research, a quantitative study was designed to explore whether internally-produced, deceptive

psycholinguistic cues, would manifest as graphological discrepancies, depending on the scenario's content and context.

Chapter 3: Research Method

Introduction

This quantitative study was designed to explore whether internally-produced, deceptive psycholinguistic cues would manifest as graphological discrepancies depending on the scenario's content and context. A two-way ANOVA was used to analyze the differences between the groups of IVs, truthful or deceptive written statements, and the measurable DV, graphological spacing discrepancies. Specific cognitive domains and executive functioning traits, such as cognitive flexibility and working memory, along with cognitive load, were measured and compared to graphological spacing discrepancies. The relative contribution of these IVs were explained through multiple regression analyses.

An exploration was conducted of indirect relationships, between deception-induced cognitive load, and possible behavioral influences on graphological traits. Behavioral traits, such as moral disengagement, were measured and compared to graphological discrepancies. To investigate possible interaction effects, a two-way ANOVA was run. Interactions of attempted behavioral control and induced cognitive load, on measurable graphological discrepancies, were explored.

Within the chapter, the significance of the IVs, truthful or deceptive written statements, psychological inventory scores, and cognitive load, along with the DV, graphological spacing discrepancies, was described for each of the seven research questions and concomitant hypotheses. The statistical tests were chosen based on the type and number of variables for each research question. Design constraints were

minimal for this study. Time and group testing arrangements were the only noted constraints. In a quasi-experimental research design, results are generalizable in natural settings, while considering the involvement of human behaviors. In an effort to prevent inconclusive results, multiple IVs were manipulated and investigated for statistically significant relationships.

The target population, consisting of law enforcement officers and college students, was selected based on convenience sampling with stratification of population characteristics. Participants were randomly invited to participate while also randomly assigned to the experimental and control groups. All research participants received verbal and written instructions regarding participants' rights, the nature of the experiment, and participants' expected behavior during the experiment. Psychological inventories, the procedure for measuring spacing discrepancies, operationalization of the variables, and statistical data analyses used, were explained. Psychological stressors are none to minimal for this experiment, and procedures for keeping participants' data secure and confidential were discussed.

Research Design and Rationale

Variables

The IVs, truth or deceptive written statements, along with cognitive load, were introduced through research participants' written statements. Cognitive load was introduced to the experimental group, as extra written directions, while the participants were writing. Remembering number strings and multiple words for later recall were expected to induce extra mental load, manifesting as measurable writing variances (Yu,

Epps, & Chen, 2011). Deception cannot be observed directly and must be operationalized.

By measuring an observable indicator, such as graphological discrepancies, the conceptual variable becomes operationalized (Stangor, 2015). Possible deceptive cues in known deceptive statements were identified, based on the measurable discrepancies in graphological spacing. The frequency and extent of discrepancies were compared to those in truthful statements. As a result, the deceptive cue became a measurable variable, conducive to quantitative analysis.

Lying causes anxiety, which causes leakages in our behaviors, body movements, and expressions (Aviezer, Trope, & Todorov, 2012; Zuckerman & Driver, 2014). Leakages are excellent indicators of behaviors because leakages are unconsciously performed. Handwriting has been referred to as brainwriting because handwriting originates with neural impulses from our subconscious. (Schuetz, 2013). Handwriting is a permanent snapshot of an individual's emotional state. So, the expectation was, behavioral leakages possibly would be exhibited as variances in handwriting.

The DV, quantifiable graphological spacing discrepancies, was measured using a NIST traceable, calibrated caliper. Spacing discrepancies were identified as the sum of spacing variances in the left margin, between words, and between sentences. Spacing discrepancies were defined as spaces greater than or equal to twice the space prior to, or after the varied space, or both. Left margin spacing discrepancies were defined as a left margin indented greater than the left margin of the first complete line in an indented paragraph, or a left margin indented greater than the first line of a paragraph in a block

formation. The unit of measurement was millimeters, and the spaces were measured to two decimal places. The calibration accuracy of the caliper is +/- 0.01mm.

The formula for defining a spacing discrepancy was written after reviewing written statements in closed criminal case files. Repeated graphological patterns were noted and compared to known case outcomes and investigation findings. Prior researchers have combined writers' verbal and lexical skills with spatial orientation, regarding letter height and slant, to create writing scores for cognitive impairment (Balestrino et al., 2012). The focus of this study was graphological spatial orientation as related to margin, word, and sentence spacing variances. Relationships among behavioral effects of deception, specific cognitive and behavioral traits, and cognitive load were explored. Graphological spacing discrepancies in deceptive and truthful handwritten statements were compared. The behavioral effects of deception, along with spontaneity, working memory, and cognitive load on graphological spacing, were also investigated.

Connection to Research Questions

In this quantitative study, relationships were examined between graphological discrepancies and specific cognitive domains to investigate deception's possible behavioral influences on handwriting. Elements of deception detection, not previously addressed in prior research studies, were explored through the investigation of the research questions. Cognitive and behavioral demands were investigated when content and context varied spontaneously (Masip et al., 2012; Vytal et al., 2013). The indirect effects of deception were explored by identifying, quantifying, and comparing graphological spacing discrepancies in participants' written statements.

The behavioral effects of deception are unknown with regard to quantifiable deceptive cues presented in handwritten statements. Anxiety affects verbal and spatial working memory (Vytal et al., 2013). Researchers reported anxiety effects may be instrumental, in explaining deception detection accuracy rates, in verbal and written detection techniques (Vytal et al., 2013). Investigating the research questions furthered the exploration of deceptive psycholinguistic cues, behavioral traits, and cognitive traits on graphological discrepancies.

Design Constraints and Consistency in Design Choice

As a result of selecting a quasi-experimental design, results can be generalized to field research settings. IVs cannot be controlled completely because human behavior is involved (Frankfort-Nachmias & Leon-Guerrero, 2015). The lack of random selection of research participants and the unpredictability of human behavior dictates a quasi-experimental versus a true experimental design. Due to the quantity of handwriting exercises and psychological measures in the study, time conservation was a factor when recruiting participants. One testing site and one-time block for each participant group was needed.

This design was conducive to law enforcement and college students' availability and scheduling. Classrooms were made available at the college and police precincts for testing. Convicted criminals, who are also familiar with deception detection techniques used in interrogations and interviews, were not used for this study. Group testing of inmates is considered a security risk.

Prior research seeking to establish graphology as a valid and reliable method to describe personality has remained inconclusive. Bradley (2011) suggests the reason for inconclusive studies possibly began with the definition of personality. By using personality inventories, the problem is evaded because researchers decide, while creating inventories, which items are applicable to the study. Then ensuing researchers integrate similar categories (Bradley, 2011). In an effort to prevent inconclusive results, psychological inventory results were used to explain a portion of the writing variations seen. The objective was to investigate the possible significance for measured cognitive traits, to measured behavior-induced graphological spacing discrepancies.

The writing samples collected varied in content and context, and the samples were not dependent on the cognitive inventories administered. This design was in opposition to collecting samples solely based on content or cognitive inventory results. The specific research design was a quasi-experimental design. The experimental and control groups were randomly assigned because variables such as language, demographics, and gender, do not affect individual variances in written statement analyses (Tang, 2012). If the differences in the experimental groups' results are significantly larger than the control groups' results, then a cause and effect relationship, between the tested variables, can be inferred (Frankfort-Nachmias & Leon-Guerrero, 2015).

Methodology

The target population of interest was college students 18 years or older as of September 2015 and law enforcement officers. Both groups were fluent in English, and during the experiment, they received all verbal and written instructions in English. Two

characteristics were used in stratifying the target population. Participants were asked whether they had working knowledge or familiarity of deception detection techniques used in criminal interrogations and interviews. Participants were also asked about their availability to be tested in a group in a single sitting.

Potential participants within each stratum were randomly invited to participate. Invitations were offered to students enrolled at a regional college and personnel from regional law enforcement agencies. Stratified sampling reduces research costs while increasing the level of accuracy for population estimates (Frankfort-Nachmias & Leon-Guerrero, 2015). An increased level of accuracy is performed when homogenous strata are created. As a result, a more heterogeneous population will be created when populations are combined (Frankfort-Nachmias & Leon-Guerrero, 2015). Tang (2012) determined language, gender, and demographics do not influence individual variances in handwriting. So, additional strata to separate these characteristics was unnecessary. In fact, doing so may lessen the value of the stratified sample because the number of samples for each stratum would be extremely large (Frankfort-Nachmias & Leon-Guerrero, 2015).

Simple random sampling will not guarantee the inclusion of the preferred participant characteristics (Creswell, 2014). Therefore, stratified sampling was used (Creswell, 2014). The randomness of the population's characteristics in simple random sampling may also affect the accuracy of generalizability for results (Creswell, 2014). A statistical power table was referenced to determine the minimum number of participants per strata needed to produce a power of .80 with $\alpha = .05$ (Stangor, 2015). The determined

number for a two-way ANOVA was 28, with a total participant number of 56, yielding a large effect size of .40. The determined number for a multiple regression with two IVs was 67 participants, yielding a medium effect size of .30.

Procedures for Participation, Recruitment, and Data Collection

Flyers were posted at regional police departments and a regional college, inviting law enforcement officers and students to participate in the research study. On the day of the study, research participants were given verbal and written instructions, regarding participants' rights, the nature of the experiment, and the participants' expected behavior, during the experiment. Participants were informed their participation was part of a deception detection study, and part of the experiment included psychological inventories, in order to explore possible relationships between behavioral traits and deceptive cues.

Participants' test packets were coded for location and test groups. Not including the pre-test and post-test, there were four writing exercises. The test packets were designed, so participants' assignment to the control or experimental group varied for each writing exercise. The participants chose a test packet and recorded the identification code for future reference of test results. All relevant information regarding participants' rights, the nature of the experiment, and the participants' expected behavior, was provided on a typed form using non-scientific terms and language. The participants were given the opportunity to ask questions, regarding the consent form, prior to signing. Prior research has been used to indicate language, gender, and demographics do not influence individual variances in handwriting, so the above information was not collected (Tang, 2012). Participants were asked to complete a questionnaire with items relating to their abilities

to produce handwritten statements. The participants were asked whether they were aware of any conditions, illnesses, or injuries, preventing or affecting their ability, to recall information and write statements, according to instructions.

Data were collected from two groups of individuals, at separate locations, as defined in the sampling strategy. Each participant received multiple sheets of unlined, coded paper, and a pen. Each test packet was designed, so the participants' instructions for each writing exercise appeared random. Participants were allocated four minutes for each writing exercise.

Three psychological inventories were administered after the handwriting exercises. The inventories consisted of executive functioning and behavioral traits tests. An investigation was conducted for possible relationships between attempted behavioral control and cognitive load. Relationships between these behavioral traits and measurable graphological discrepancies, during truthful and deceptive writing, were also investigated.

After testing, all participants received a verbal debriefing, along with a written statement, explaining the purpose and significance of the research. Due to possible time constraints for the participants, an email was provided for any questions or concerns the participants may have. A tentative date was announced when the research results would be shared with the participants. Students, not returning the next semester, were encouraged to send an email requesting the test results.

Instrumentation and Operationalization of Constructs

Cognitive Flexibility Inventory. The CFI is a 20 item, self-report measure, for aspects of cognitive flexibility, necessary for individuals to successfully challenge and replace maladaptive thoughts, with more balanced thinking (Dennis & Vander Wal, 2010). The Control and Alternatives subscales were measured. Discrepancies in participants' graphological spacing were analyzed for the participants' abilities, to perceive deceptive situations as controllable, and to perceive multiple alternatives for explanations and solutions, to deceptive situations. Permission was obtained from the developers to use the CFI in this research study (see Appendix A).

Research Question 3: Whether or not less mental flexibility, as measured by the CFI, has an effect on a participant's ability to maintain consistent graphological spacing. To test Research Question 3, scores from the Alternative scale, items (1-3, 5-6, 8, 10, 12-13, 15-16, 18, & 20), and Control scale, items (4, 7, 9, 11, 14, 17, & 19) were compared to deceptive handwriting. The scores were analyzed for possible relationships, explaining the frequency of graphological discrepancies. The normative sample was composed of 196 undergraduates from a private, mid-western university (Dennis & Vander Wal, 2010).

The majority of the participants were in their junior and senior years of college. The CFI has a reliable two-factor structure with excellent internal consistency, and a high 7-week, test-retest reliability (Dennis & Vander Wal, 2010). Convergent construct validity was obtained with the CFI's correlations with the Cognitive Flexibility Scale and Ways of Coping Checklist-Revised. Concurrent construct validity support was shown

with the CFI's correlation with the Beck Depression Inventory-2nd Edition (Dennis & Vander Wal, 2010).

Unethical Deception Scale. The UDS is a 12 item, self-report measure to assess frequency of deceptive practices (Barsky, 2011). Permission was obtained from the developer to use the UDS in this research study (see Appendix B).

Research Question 5: Whether participants' scores for moral disengagement and unethical work behavior, as measured by the UDS, correlate with graphological spacing discrepancies. To test Research Question 5, overall UDS scores were compared to deceptive handwriting. The scores and writing samples were analyzed for possible relationships, explaining the frequency of graphological discrepancies. The normative sample was composed of 164 undergraduates, recruited from business and psychology classes at a private, Southern university (Barsky, 2011). The average participant age was 19.2 years. The UDS showed high internal consistency (Barsky, 2011).

The UDS showed validity, as a measure of unethical behavior. The number of unethical decisions were significantly correlated with responses, to the unethical behavior scale ($r = .43, p = < .01$) (Barsky, 2011). A second study used the UDS as a dependent measure. The participants were 83 employed individuals. The sample was composed of working adults, from professional MBA and executive MBA classes at a private Southern U.S. university, and participants from a professional association of purchasing managers. The UDS results noted acceptable internal consistency (Barsky, 2011).

Behavior Rating Inventory of Executive Function[®]-Adult Version. The BRIEF[®]-A is a self-report measure was used to capture the views of an adult's executive

functions and self-regulation, within the everyday environment (Roth, Isquith, & Gioia, 2005). The Working Memory and Inhibit domains, within the Problem Solving and Behavior Regulation subscales, were measured and analyzed for possible effects, indicating how graphological spacing discrepancies are influenced by cognitive efforts and attempted behavioral control. Per the publisher, permission from the developers is not needed, because the purchased instrument's manner of administration would not be altered.

Research Question 7: Whether participants' scores on the Working Memory and Inhibit domains, measured by the BRIEF[®]-A, correlate with participants' graphological spacing discrepancies. To test Research Question 7, scores from the Working Memory domain, items (4, 11, 17, 26, 35, 46, 56, & 68), and the Inhibit domain, items (5, 16, 29, 36, 43, 55, 58, & 73) were compared to deceptive handwriting. The scores were analyzed for possible relationships, explaining the frequency of graphological discrepancies. The normative sample was composed of 1136 participants from varied racial and ethnic backgrounds, education backgrounds, and geographic regions (Roth et al., 2005). The ages were divided into two groups, 18-39 years and 40-90 years. The BRIEF[®]-A was considered useful for a wide variety of developmental, systemic, neurological, and psychiatric disorders (Roth et al., 2005).

The internal consistency results were moderate to high for the normative sample and the mixed, clinical, or healthy, adult sample (Roth et al., 2005). Healthy adults' correlations across the clinical scales ranged from .82 to .93, over an average interval of 4.22 weeks. Interrater agreement correlations, between self-report forms and informant

report forms, were moderate, ranging from .11 to .68. A moderate proportion of individuals, in the 18-39 age range, rated themselves as having substantially greater difficulties than the informants reported. Convergent and discriminant validity evidence correlated strongly between the BRIEF[®]-A's Inhibit and Working Memory scales, and the Frontal Systems Behavior Scale's[®] Apathy and Executive Dysfunction scales (Roth et al., 2005).

For the purpose of this study, deception cues were identified as graphological spacing discrepancies in left margins, between words, and between sentences. By measuring an observable indicator of deception, written deceptive cues become operationalized (Stangor, 2015). Known deceptive written statements were compared to known truthful written statements, while measuring and comparing graphological spacing. A NIST traceable, calibrated caliper was used to measure the graphological spaces in written statements.

Word and sentence spacing discrepancies were defined, as measured spaces greater than, or equal to twice the space prior to, or after the space, or both. Left margins' measurements were defined as discrepancies, if the resulting positive measure of a left margin, indented greater than or equal to twice the left margin of the complete line, above or below the measured margin. Each spacing discrepancy was given a score of 1. The discrepancy scores represent possible areas of doubt or deception within the written statements. For example, a paragraph with three graphological discrepancies would receive a score of 3.

Data Analysis

Research Question 1: Whether graphological discrepancies are evidenced through analysis of left margin indentions, word spacing, and sentence spacing, in efforts to detect deceptive sentences.

H_01 : Deceptive sentences will not have left margin spacing variances greater than, or equal to twice previous, or following margins.

H_a1 : Deceptive sentences will have left margin spacing variances greater than, or equal to twice previous, or following margins.

H_02 : Deceptive sentences will not have word spacing variances greater than, or equal to twice previous, or following words.

H_a2 : Deceptive sentences will have word spacing variances greater than, or equal to twice previous, or following words.

H_03 : Deceptive sentences will not have sentence spacing variances greater than, or equal to twice previous, or following sentences.

H_a3 : Deceptive sentences will have sentence spacing variances greater than, or equal to twice previous, or following sentences.

Research Question 2: Whether the lack of graphological discrepancies are evidenced through analysis of left margin indentions, word spacing, and sentence spacing, in efforts to detect truthful sentences.

H_04 : Truthful sentences will have margin spacing variances greater than, or equal to twice previous, or following margins.

H_{a4}: Truthful sentences will lack margin spacing variances greater than, or equal to twice previous, or following margins.

H₀₅: Truthful sentences will have word spacing variances greater than, or equal to twice previous, or following words.

H_{a5}: Truthful sentences will lack word spacing variances greater than, or equal to twice previous, or following words.

H₀₆: Truthful sentences will have sentence spacing variances greater than, or equal to twice previous, or following sentences.

H_{a6}: Truthful sentences will lack sentence spacing variances greater than, or equal to twice previous, or following sentences.

Research Question 3: Whether or not less mental flexibility, as measured by the CFI, has an effect on a participant's ability to maintain consistent graphological spacing.

H₀₇: Participants scoring lower on the CFI will not reveal more graphological spacing discrepancies than those scoring higher on the CFI.

H_{a7}: Participants scoring lower on the CFI will reveal more graphological spacing discrepancies than those scoring higher on the CFI.

Research Question 4: Whether spontaneously produced deceptive writing exhibits variances in graphological spacing.

H₀₈: Participants' deceptive writing will not demonstrate more graphological spacing discrepancies during spontaneous, versus non-spontaneous writing.

H_{a8}: Participants' deceptive writing will demonstrate more graphological spacing discrepancies during spontaneous, versus non-spontaneous writing.

Research Question 5: Whether participants' scores for moral disengagement and unethical work behavior, as measured by the UDS, correlate with graphological spacing discrepancies.

H₀9: Participants scoring higher on the UDS for moral disengagement and unethical work behavior will not reveal fewer graphological spacing discrepancies, than those scoring lower on the UDS.

H_a9: Participants scoring higher on the UDS for moral disengagement and unethical work behavior will reveal fewer graphological spacing discrepancies, than those scoring lower on the UDS.

Research Question 6: Whether written statements void of personal memories show increased graphological discrepancies.

H₀10: Participants' writing based on personal memories, will not demonstrate fewer graphological discrepancies, than participants' writing void of personal memories.

H_a10: Participants' writing based on personal memories, will demonstrate fewer graphological discrepancies, than participants' writing void of personal memories.

Research Question 7: Whether participants' scores on the Working Memory and Inhibit domains, measured by the BRIEF[®]-A, correlate with participants' graphological spacing discrepancies.

H₀11: Participants scoring high in the Working Memory and Inhibit domains of the BRIEF[®]-A Inventory, will not display fewer graphological spacing discrepancies, than those with lower scores in the corresponding domains.

H_{a11}: Participants scoring high in the Working Memory and Inhibit domains of the BRIEF[®]-A Inventory, will display fewer graphological spacing discrepancies, than those with lower scores in the corresponding domains.

IBM SPSS statistics software was used for statistical analyses. Data sets for all variables were inspected and corrected where necessary, prior to statistical analyses. Possible data errors for this study may be missing data, data entry errors, and measurement errors when measuring the graphological spacing discrepancies. An examination of the study's descriptive statistics should highlight possible data errors. The Friedman's test was used in Research Questions 1 and 2, to determine whether there are differences in spacing discrepancies between truthful writing, deceptive writing, and writing produced under cognitive load. The same participants were used in all experimental conditions. Post hoc testing for pairwise comparisons was performed with a Bonferroni correction for multiple comparisons (Laerd, 2015).

Hierarchical multiple regression analysis was used to test Research Questions 3, 5, and 7. Cognitive load and cognitive and behavioral domain scores are not a part of the main experimental manipulation, but the inventory scores and effects of cognitive load may explain some of the variances, with the DV (Field, 2013). A linear regression equation, the statistical significance of the overall model and each IV, and a measure of effect size was calculated. A correlation matrix was also created for a quick examination of relationships, between IVs and the DV, along with checking for multicollinearity (Field, 2013).

Research Questions 4 and 6 were tested with a two-way ANOVA, because two IVs exist. Different participants were used in all experimental conditions. Levene's test for homogeneity of variance was performed. Interpretation of main effects were not necessary, if an interaction involving a particular variable was significant. Bonferroni post hoc tests were performed, if interpretations of main effects were needed (Field, 2013).

Threats to Validity

Internal and External Validity

Maturation, testing, and instrumentation was demonstrated equally, among the experimental and control groups. Regression was controlled, because experimental and control groups were randomly assigned. By using randomly assigned control groups, effects from selection-history and selection-maturation were neutralized (Frankfort-Nachmias & Leon-Guerrero, 2015). Mortality was controlled, because the testing, occurred at one location, in a single setting, within a specified amount of time. Participants were randomly assigned, and the location and time was the same for all participants within a group.

Laboratory settings are typically nonthreatening and less anxiety-inducing, than the natural setting of a police station, or the site of a criminal investigation (Frankfort-Nachmias & Leon-Guerrero, 2015). The possibility exists that characteristics of the laboratory setting could cause the experimental group to be less effective, than in the target population. Reactive arrangements were lessened by using typed instructions for all participants. Reactivity was also addressed by including two significant IVs, written

statements and cognitive load. Multiple IVs may negate an additional threat to external validity.

By keeping the viewed scenario contents and requests for written statements equivalent, the participants' behavioral indicators had sampling validity (Frankfort-Nachmias & Leon-Guerrero, 2015). A NIST traceable, calibrated caliper was used to measure graphological variances, providing the study empirical validity. Inter-rater reliability was established by two people, measuring graphological spacing discrepancies with a calibrated instrument. Both measurers followed a specific measuring protocol to insure reliability of measurements (see Appendix C). Correlation of measured results defined internal consistency.

The metric variable is a combination of two methods for measuring deception. These methods are for measuring left margin indentions and for measuring spaces between words and sentences. To confirm construct validity, each method was tested individually in Research Questions 1 and 2. The hypothesis was, for each of the three methods for measuring, graphological spacing would indicate the presence of behavioral leakages in the same general areas, as theorized for verbal statements (Zuckerman & Driver, 2014).

Ethical Procedures

IRB approval, with an assigned IRB approval number and expiration date of 02-02-16-0360603 and 2/1/17, and institutional and agency permissions were needed prior to collection of data. Prior to the experiment, the research participants were briefly informed of the purpose for the experiment, identifying possible deception detection

cues. No part of the study was intended to induce strong emotional reactions. The participants were given a written explanation of the study, including their right to withdraw from the study, or to ask questions before or after the study. Although deception detection constitutes a part of the study, participants were not deceived, regarding their roles in the study. At no time were the participants coerced to participate, or continue participating in the study.

All personal participant information was kept confidential. The participants' names were not recorded, but coded identification numbers were placed on each of the participant's writing samples. Therefore, only individual participants were able to associate their name with their coded identification number. Consent forms and participants' study responses were submitted separately, so the responses remained confidential. On completion of the experiment, all participants were debriefed, regarding the research hypotheses and purpose of the experimental procedures (Frankfort-Nachmias & Leon-Guerrero, 2015).

All research data were scanned and stored on a flash drive and kept in a secured, locked location. After these data were scanned, the paper was shredded and destroyed. Data averages and summaries will possibly be used in future research and publications. All experiment data will be destroyed, when the information is no longer relevant to the deception detection research.

Summary

This quantitative study was designed to explore whether deceptive psycholinguistic factors are carried over to written statements, in the form of

graphological discrepancies. Indirect relationships, between cognitive load and behavioral influences, were also investigated by measuring and comparing specific cognitive domains and executive functioning traits, to graphological spacing discrepancies. The IVs are truthful or deceptive written statements, psychological inventory scores, and cognitive load. The DV, graphological spacing discrepancies, was defined as quantifiable spacing discrepancies in left margins, between words, and between sentences.

The target population of interest was college students, 18 years or older, and law enforcement officers. Stratified sampling of the population reduced research costs and increased the level of accuracy for population estimates (Frankfort-Nachmias & Leon-Guerrero, 2015). Unlike simple random sampling, stratified sampling guaranteed the inclusion of the preferred participant characteristics. Both groups were fluent in English, and they had working knowledge or familiarity with deception detection techniques.

By using a quasi-experimental research design, the results were generalizable in natural settings, while considering the involvement of human behaviors. The experimental and control groups were randomly assigned, because variables, such as language, demographics, and gender, do not affect individual variances in written statement analyses (Tang, 2012). The pre-test and post-test served as the baseline for the graphological analyses of both groups, while controlling for historical events (Frankfort-Nachmias & Leon-Guerrero, 2015). By manipulating multiple IVs, statistically significant relationships were investigated, as they related to the content and context of the participants' writing samples.

Statistical tests included, Friedman's two-way ANOVA, hierarchical multiple regression, and two, two-way ANOVAs. These statistical tests were chosen, based on the type and number of variables for each research question. Availability of tests in the IBM SPSS statistical software was also a consideration when choosing tests. Viewing multiple, statistical relationships aided the empirical based conclusions of possible deception-induced, cognitive, and behavioral effects on graphological spacing.

Threats to internal and external validity should be minimal for this study. Maturation, testing, and instrumentation were demonstrated equally among the experimental and control groups. Regression and mortality were controlled, and effects from selection-history and selection-maturation were neutralized. Reactivity was addressed and reactive arrangements lessened, by the design of the testing protocols. The nonthreatening and less anxiety-inducing testing environment could cause the experimental group to be less effective, than in the target population. The statistical analyses and investigation findings are reported and discussed in Chapter 4.

Chapter 4: Results

Introduction

This quantitative study was designed with the intent to further graphological deception detection research by identifying written psycholinguistic deceptive cues. In an effort to fill gaps in these areas of research, the purpose for the study was first to determine whether psycholinguistic factors, detected in deceptive verbal statements, were carried over to written statements, in the form of graphological discrepancies. Specific cognitive domains and executive functioning traits, relating to behavior regulation and problem solving, were measured and compared to graphological spacing discrepancies. Indirect relationships between deception-induced cognitive load and possible influences on graphological traits were investigated. Behavioral traits and cognitive flexibility were measured and compared to graphological discrepancies, to investigate possible correlations between attempted behavioral control during deception and measurable graphological discrepancies.

Investigations were conducted, by reason of the research questions, to determine whether graphological discrepancies were detected. The investigations were performed in efforts to detect truthful and deceptive statements in handwritten statements. The content and context of the writing samples were considered, when measuring and comparing the writers' spacing discrepancies, along with writers' specific cognitive and behavioral domain scores. The first two research questions were written to test whether internally-produced, deceptive psycholinguistic cues would manifest as graphological spacing discrepancies. Mental flexibility, unethical work behavior, working memory,

and inhibitions control were investigated in research questions 3, 5, and 7, for possible effects on individuals' abilities to maintain consistent graphological spacing. The effects of spontaneous tasks, participants' working memory, and cognitive load on deceptive written statements, were also investigated in research questions 4 and 6.

Significant changes in graphological spacing were interpreted as writing pattern discrepancies. These discrepancies, as introduced in hypotheses 1 through 6, were evidenced through analyses of left margin indentions, word spacing, and sentence spacing, when delineating truthful versus deceptive sentences. As greater cognitive load is placed on executive functioning, less mental flexibility occurs, which was expected to affect a subject's ability to maintain consistent graphological spacing. Cognitive flexibility, as measured by the CFI, was also used to indirectly measure the relationship of cognitive load's effects on graphological spacing. In hypothesis 7, the prediction was, participants scoring lower on the CFI would reveal more graphological spacing discrepancies than those scoring higher on the CFI. Due to situation and context, some deception arises spontaneously while other types of deception may be planned or rehearsed. As noted in hypothesis 8, the expectation was spontaneously produced written deceptive statements, would exhibit greater effects of cognitive load, thereby producing greater graphological spacing discrepancies.

Moral disengagement and unethical work behavior, affect a person's deceptive behavior. These traits, as measured by the UDS, along with induced cognitive load, were expected to have an effect on graphological spacing discrepancies, as explained in hypothesis 9. The expectation was, the UDS scores and graphological spacing

discrepancies were inversely related. When no working memories are available for lie construction, and in situations where problems need to be solved quickly, cognitive load will be increased. As noted in hypothesis 10, the expectation was greater graphological spacing discrepancies existed when cognitive load was increased. In hypothesis 11, the expectation was an inverse relationship between the frequency of graphological spacing discrepancies and the Inhibit and Working Memory domain scores, as evidenced in the BRIEF®-A inventory results. Even in cases of routine deception, where working memories exist and cognitive load is usually less, individual participant's specific cognitive domains are expected to affect how deception is influenced, by cognitive efforts and attempted behavioral control.

In this chapter, the purpose of this quantitative study is reiterated in the context of the research questions. Data collection dynamics are presented to include participant response rates and the actual time frame required to achieve a representative sample. The benefits of purposive nonprobability sampling and its applicability to the study are discussed. Descriptive characteristics of the stratified sample are presented. Distribution of participants' responses were examined prior to exploring possible relationships between psychological inventory scores and graphological spacing discrepancies.

In the results section, descriptive statistics of the law enforcement and criminal justice student participants are reported. Statistical assumptions were evaluated as appropriate to the study. All findings of statistical analyses are reported according to relevance of the research question and hypotheses. Additional statistical tests are reported, along with the corresponding applicable research questions and hypotheses.

Data Collection

Data were collected over a four-week period at a college and at multiple law enforcement agencies in Southern Illinois and Western Tennessee. Recruitment flyers were posted at each location two weeks prior to data collection. The purpose for the research study, eligibility requirements for participation in the study, and the date, time, and location for data collection were noted on the flyers. Of the stratified groups recruited, the volunteered response rates were 61% for the criminal justice college students and 39% for the law enforcement officers. Sampling bias was a possibility because not all student and law enforcement participants were available or willing to participate in the study. No attempt was made to make the sample representative of a student or law enforcement population. Although nonprobability samples were used to test the research hypotheses, the samples may not be used to draw inferences about populations (Stangor, 2015). The total number of participants was 113. There were 45 male and 29 female college students, and 35 male and 4 female law enforcement personnel.

All data were collected in line with the IRB approval. The timeframes were successfully maintained. Nonprobability purposive sampling was performed and stratified purposive sampling enabled reaching the targeted sample in reasonable time. As part of the qualifying questionnaire for participation in the study, participants were asked whether they had ever received injuries causing current difficulties with either handwriting or recollection of memories. All participants volunteered additional characteristics pertaining to medication, education, and specific age ranges (see Table 1).

Table 1

Group Characteristics as a Percentage of the Sample Data

Characteristic	Students (n = 74)	Law enforcement (n = 39)
Injury affecting handwriting	4	2
Injury affecting memory		2
Medication		
None	58	27
Over-the-counter	1	1
Prescription	11	9
Both	4	2
Age		
18-23	64	16
24-29	6	9
30-35	1	7
36-41		5
42-47		1
48-53	2	1
53-65	1	
Education		
High school diploma		2
Some college	67	28
College diploma	7	9

Results

Left margin spacing discrepancy measurements were defined as spaces greater than or equal to twice the previous left margin, beginning with the line after the first complete line in a paragraph. Sentence spacing discrepancies were defined as spaces greater than or equal to twice the space after the previous sentence. Word spacing discrepancies were defined as spaces greater than or equal to twice the space prior to, after the varied space, or both. Spaces after the last word or period in a line were not measured for discrepancies. Each spacing discrepancy was given a score of 1. The

scores were standardized by dividing each total for margin, sentence, and word spacing discrepancies, respectively, by the total number of sentences in the paragraph. A NIST traceable, calibrated digital caliper was used for all measurements. All measurements were recorded to two decimal places.

The Friedman's two-way ANOVA by ranks test was performed to determine whether there were differences in spacing discrepancies between truthful writing, deceptive writing, and writing produced under cognitive load. Post hoc testing for pairwise comparisons were performed with a Bonferroni correction for multiple comparisons (Laerd, 2015). The Friedman's test was performed three times, using the same categorical IV but different DVs. The continuous DVs were defined as discrepancies in left margin spacing, spacing discrepancies between written sentences, and spacing discrepancies between written words. The Friedman's test was chosen based on the research study design, the nature of data, and the availability of the statistical test in the IBM SPSS statistical program.

A two-way ANOVA was conducted twice to establish whether there was an interaction effect between nominal IVs on a continuous DV. The first two-way ANOVA was conducted to examine the effects of spontaneously written statements and cognitive load on spacing discrepancies. The second, two-way ANOVA performed tested the effects of memory-based written statements and cognitive load on spacing discrepancies. Residual analyses were performed to test for the assumptions of the two-way ANOVAs, along with testing for main effects (Field, 2013; Laerd, 2015).

A hierarchical multiple regression analysis was entered to compare multiple regression models. The total model, composed of the IVs (UDS, CFI, BRIEF[®]-A Inhibit and Working Memory scales along with cognitive load) added with each model, significantly contributed to variation in the DV (spacing discrepancies). After determining whether the hierarchical multiple regression model was a good fit for these data, the differences between the models were evaluated, along with their statistical significance. Next, after interpreting the overall model fit, the coefficients of the regression model were interpreted and reported, not to make predictions, but to further understand the importance of the added IVs (Nathans, Oswald, & Nimon, 2012).

Descriptive Statistics

Of the 113 participants recruited to the study, participation was 100%, with no excluded cases. The Friedman's test results were analyzed for differences between groups on each continuous DV (see Table 2). The test was performed three times for each DV, spacing discrepancies in left margins, spacing discrepancies between sentences, and spacing discrepancies between words. For each of the two-way ANOVAs, interaction effects were examined between the IVs on the continuous DV, mean spacing discrepancies (see Tables 3 & 4). Statistical analytical results were examined from the hierarchical multiple regression to indicate whether the IVs, added with each model, were statistically, significantly contributing to variation in the DV (see Table 5).

Table 2

Median Spacing Discrepancies by Categories

	Truthful statements	Deceptive statements	Statements with cognitive load
Left margin	0.17	0.20	0.25
Between sentences	0.00	0.00	0.00
Between words	0.33	0.50	0.75

Table 3

Spacing Discrepancy – Spontaneity and Cognitive Load

Spontaneous directions	Cognitive load	<i>M</i>	<i>SD</i>	<i>N</i>
Non-Spontaneous	No load	1.06	0.81	28
	Load	1.18	0.61	29
	Total	1.12	0.71	57
Spontaneous	No load	0.91	0.60	29
	Load	1.42	0.85	27
	Total	1.16	0.77	56
Total	No load	0.98	0.71	57
	Load	1.30	0.74	56
	Total	1.14	0.74	113

Table 4

Spacing Discrepancy – Memory-based Writing and Cognitive Load

Memories	Cognitive load	<i>M</i>	<i>SD</i>	<i>N</i>
No Memories	No load	1.21	0.60	28
	Load	0.97	0.73	27
	Total	1.09	0.67	55
Memories	No load	1.43	0.86	28
	Load	0.94	0.67	30
	Total	1.18	0.80	58
Total	No load	1.32	0.74	56
	Load	0.96	0.69	57
	Total	1.14	0.74	113

Table 5

Hierarchical Multiple Regression Independent Variables by Models

	<i>M</i>	<i>SD</i>	<i>N</i>
Spacing discrepancy	0.99	0.88	113
UDS	30.48	11.84	113
CFI	76.65	10.39	113
BRIEF®-A, I & WM	114.43	18.08	113
Cognitive Load	0.50	0.50	113

Statistical Assumptions

Friedman’s two-way ANOVA by ranks test. The Friedman’s test is the nonparametric alternative to the one-way ANOVA, with repeated measures. The Friedman’s test can be used to test for differences between data conditions, when the DV, being measured, is continuous, and these data have marked deviation from normality. The first two basic assumptions of the Friedman’s test relate to research study design and the nature of these data. One continuous DV and an IV, with three or more categorical

related groups, make up these data (Laerd Statistics, 2015). Because of normal writing inconsistencies, Friedman's test was an excellent choice. Normal distribution and perfectly symmetrical variable properties are not expected in handwriting (Field, 2013; Zhang, Liu, & Zhao, 2015).

Two-way ANOVA. The first, two-way ANOVA was conducted to examine the effects of spontaneous directions and cognitive load, on written spacing discrepancies. The second, two-way ANOVA was conducted to examine the effects of memory-based statements and cognitive load, on written spacing discrepancies. Both groups of data had a continuous DV, two categorical IVs, with two or more groups in each IV, and independent observations. Outliers were assessed by inspection of boxplots. Normality was assessed using Shapiro-Wilk's normality test, and homogeneity of variances was assessed by Levene's test.

In the first, two-way ANOVA, there were three outliers, assessed as being 1.5 box-lengths from the edge of the box, in the boxplots. Two outliers were identified in the Non-Spontaneous, No Load group, and one outlier was identified in the Spontaneous, Load group. There were no outliers for the boxplots identified, as Non-Spontaneous, Load, and Spontaneous, No Load. In the second, two-way ANOVA, there were no outliers for the writing samples in the group, No Memories, No Cognitive Load. There were three outliers identified in the remaining groups. One outlier, in the group No Memories, Cognitive Load, was greater than three box lengths from the edge of the box, in the boxplot. The writing samples, in the group Memories, No Cognitive Load, had one outlier, as well as the group, Memories, Cognitive Load. The extreme outlier, in the No

Memories, Cognitive Load group, was calculated, based on a truthful written statement. The outlier, in the Memories, No Load group, was also calculated, based on a truthful written statement.

None of the outliers, for either two-way ANOVA, were results of data entry errors or measurement errors. In all groups of data, the outliers were the results of significant, between-word spacing discrepancies, as compared to left margin and between-sentence spacing discrepancies. Although not ideal from a statistical perspective, there was no good reason to reject them as invalid (Laerd, 2015). A robust two-way ANOVA is not available in IBM SPSS statistics software. All outliers were included, without modifying or transforming these data, because removing the outliers created more outliers.

Data were normally distributed in the first, two-way ANOVA, as assessed by Shapiro-Wilk's test, $p = .114$, for Non-Spontaneous, Load samples. The non-normally distributed results were Non-Spontaneous, No Load, $p = .001$; Spontaneous, No Load, $p = .004$; Spontaneous, Load, $p = .031$. The tests were run, because results from ANOVAs are considered fairly robust, with respect to Type I errors (Wilcox, 2012). Data from the second, two-way ANOVA, were normally distributed in the groups, Memories, No Load, $p = .056$, and No Memories, No Load, $p = .099$. Data from the groups, No Memories, Load, $p = .002$, and Memories, No Load, $p = .001$, were not normally distributed as assessed by Shapiro Wilk's test.

The last assumption tested was homogeneity of variances. The assumption was, the variances of the DV are equal in all combinations of groups for the IVs. This last

assumption was tested using Levene's test of equality for variances, which found homogeneity of variances, in both two-way ANOVAs, $p = .467$, $p = .581$, respectively.

Hierarchical Multiple Regression. These data were checked against eight assumptions, prior to applying the hierarchical multiple regression model. The first two assumptions were related to the study design. Linear relationships were assessed by partial regression plots, between the DV and each IV. A visual inspection of a plot for studentized residuals, against the predicted values, was performed. There was independence of residuals, as assessed by a Durbin-Watson statistic of 2.234.

Equal error variance, homoscedasticity, was assessed by visual inspection of a plot for studentized residuals, against the unstandardized predicted values. There was no evidence of multicollinearity, as assessed by tolerance values greater than 0.1. The one residual, greater than three deviations, was not deleted, because these data points were confirmed valid, although extreme. There were no high leverage points greater than 0.2. No highly influential points, as indicated by Cook's distance, were above 1. The residuals were approximately, normally distributed, as assessed by Q-Q Plots.

Statistical Analyses

Friedman's two-way ANOVA by ranks. The Friedman's test was run to determine whether there were differences in spacing discrepancies, between truthful statements, deceptive statements, and statements written under cognitive load. Pairwise comparisons were performed with a Bonferroni correction, for multiple comparisons (Laerd, 2015). Left margin spacing discrepancies were statistically, significantly different, at the different types of written statements, $\chi^2 (2) = 14.203$, $p = .001$. Post hoc

analysis revealed statistically, significant differences in spacing discrepancies between truthful statements, $Mdn = .17$, and statements, written under cognitive load, $Mdn = .25$, $p = .006$, and between deceptive statements, $Mdn = .20$, and statements, written under cognitive load, $Mdn = .25$, $p = .050$. Between-sentence spacing discrepancies were statistically, significantly different, at the different types of written statements, $\chi^2(2) = 10.939$, $p = .004$. Post hoc analysis did not reveal statistically, significant differences. Between-word spacing discrepancies were statistically, significantly different at the different types of written statements tested, $\chi^2(2) = 41.211$, $p < .001$. Post hoc analysis revealed statistically, significant differences in spacing discrepancies between truthful written statements, $Mdn = .33$, and deceptive statements, $Mdn = .50$, $p < .001$, and between truthful statements, $Mdn = .33$, and statements written under cognitive load, $Mdn = .75$, $p < .001$.

Two-way ANOVA. An examination was made, to determine whether there was a statistically, significant interaction effect between IVs, for the DV, in both two-way ANOVAs. In the first, two-way ANOVA performed, all written statements were deceptive. There was no statistically significant interaction between spontaneity and cognitive load on the spacing discrepancy score, $F(1, 109) = 2.109$, $p = .149$, partial $\eta^2 = .019$. In the second, two-way ANOVA conducted, there was no statistically significant interaction between memory-based writing and cognitive load on the spacing discrepancy score, $F(1, 109) = .812$, $p = .370$, partial $\eta^2 = .007$. Since a non-statistically significant interaction effect was found for both ANOVAs, main effects were interpreted and

reported. Finding a non-statistically significant interaction, does not mean an interaction effect does not exist in the test population (Laerd, 2015).

Unequal number of cases in each cell of the designs, yielded an unequal sample size. There was no overlapping of explained variances to any effect based on the statistical significance testing of unweighted marginal means (Laerd, 2015). In the first, two-way ANOVA, there was no statistically significant main effect of spontaneously and non-spontaneously written statements, on the spacing discrepancy score, $F(1, 109) = .120, p = .729, \text{partial } \eta^2 = .001$. There was a statistically significant main effect of cognitive load, on the spacing discrepancy score, $F(1, 109) = 5.530, p = .020, \text{partial } \eta^2 = .048$. The statistically significant main effect, of cognitive load, was followed up with a post hoc analysis. Pairwise comparisons of the IV, cognitive load, were conducted. The marginal means, for the spacing discrepancy scores, were 0.98 ($SE = .10$) for no cognitive load, and 1.30 ($SE = .10$) for cognitive load, a statistically significant mean difference of .32, 95% $CI [.05, .59], p = .020$ (see Figure 1).

In the second, two-way ANOVA conducted, written statements were truthful and deceptive. There was no statistically significant main effect of memory-based writing, on the spacing discrepancy score, $F(1, 109) = .484, p = .488, \text{partial } \eta^2 = .004$. There was a statistically significant main effect of cognitive load, on the spacing discrepancy score, $F(1, 109) = 7.144, p = .009, \text{partial } \eta^2 = .062$. The statistically significant main effect was followed up with a post hoc analysis. Pairwise comparisons of categories for the IV, cognitive load, were conducted. The marginal means, for the spacing discrepancy score, were .958 ($SE = .096$) for cognitive load, and 1.321 ($SE = .096$) for no cognitive load, a

statistically significant mean difference of .363, 95% CI [.094, .632], $p = .009$ (see Figure 2). All data samples in Figure 1 were composed of deceptive writing, and data samples in Figure 2 were composed of truthful and deceptive writing.

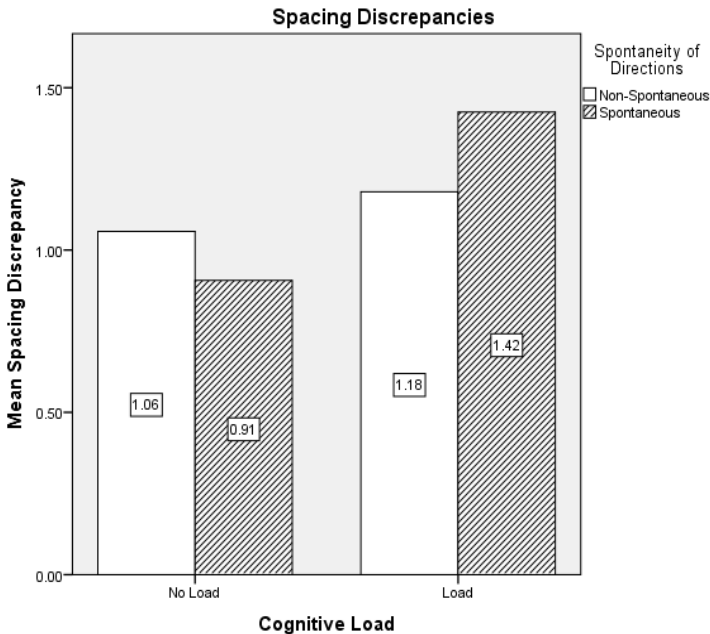


Figure 1: Independent variables, spontaneity and cognitive load

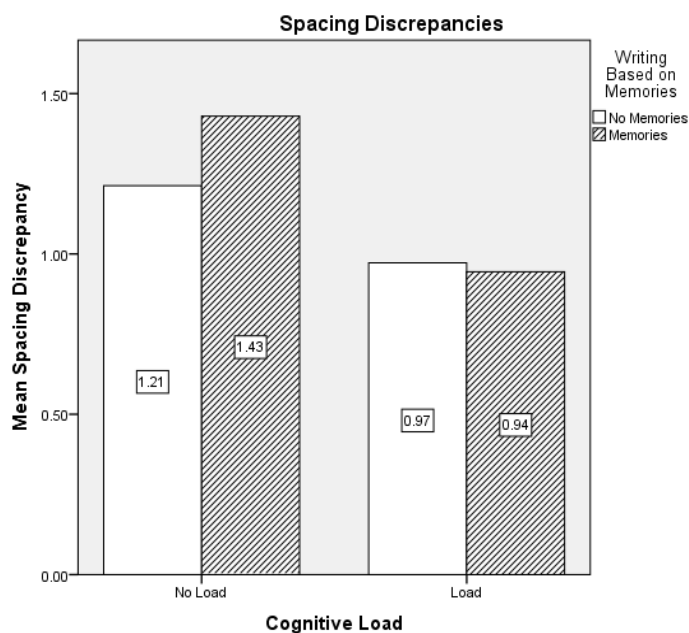


Figure 2: Independent variables, memories and cognitive load

Hierarchical multiple regression. The full model (UDS, CFI, BRIEF[®]-A Inhibit and Working Memory scales, added cognitive load) exploring the importance of added IVs was statistically significant, $R^2 = .122$, $F(4, 108) = 3.737$, $p = .007$, adjusted $R^2 = .089$. With the addition of the CFI inventory scores, to the total model, a statistically significant increase was indicated in R^2 of .074, $F(2, 110) = 4.381$, $p = .015$. The addition of the BRIEF[®]-A Inhibit and Working Memory scaled scores also led to a statistically significant increase in R^2 of .097, $F(3, 109) = 3.899$, $p = .011$. A report of the coefficients of the regression model are presented (see Table 6). A positive beta coefficient, indicating a one-unit standard deviation change, in an IV, is expected to result in a direct change in the DV, spacing discrepancy. A negative beta coefficient, indicating a one-unit standard deviation change, in an IV, is expected to result in an inverse change

in the DV (Nathans, et al., 2012). The beta weights were an excellent starting point, from which to begin exploring the contributions of the psychological inventories and cognitive load, to the regression equation.

Table 6

Hierarchical Multiple Regression, Understanding Importance of Added Variables

	Model1		Model2		Model3		Model4	
IV	<i>B</i>	β	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	<i>B</i>	β
Constant	1.317		-.273		.732		1.127	
UDS	-.011	-.145	-.008	-.109	-.004	-.059	-.007	-.090
CFI			.020	.233	.017	.202	.016	.187
BRIEF®- A					-.008	-.165	-.009	-.180
Cognitive load							-.284	-.162
R^2	.021		.074		.097		.122	
F	2.368		4.381		3.899		3.737	
ΔR^2	.021		.053		.023		.025	
ΔF	2.368		6.281		2.792		3.031	

Research Questions

Research question 1. Whether graphological discrepancies are evidenced through analysis of left margin indentions, word spacing, and sentence spacing, in efforts to detect deceptive sentences.

Research question 2. Whether the lack of graphological discrepancies are evidenced through analysis of left margin indentions, word spacing, and sentence spacing, in efforts to detect truthful sentences.

The Friedman's two-way ANOVA test results were reviewed, and statistically, significant differences in left margin indentions and spacing discrepancies, based on sentence type, were noted. The sentence types tested were truthful statements, deceptive statements, and statements written with added cognitive load. Post hoc test results were examined to reveal statistically significant differences between truthfully written statements and written statements with added cognitive load, and between deceptively written statements and written statements with added cognitive load. No statistically significant difference was found between truthfully written statements and deceptively written statements.

The Friedman's test results were examined, and statistically, significant differences in between-sentence graphological spacing and spacing discrepancies, based on sentence type were found. The sentence types tested were truthful statements, deceptive statements, and statements written with added cognitive load. Post hoc analyses did not show significant differences between sentence spacing and sentence type. These findings were not surprising, considering the limited number of between-sentence spacing discrepancies, detected during between-sentence measurements (see Table 2).

Through the analysis of the Friedman's test results, statistically, significant differences were indicated in between-word spacing and graphological spacing

discrepancies, based on sentence type. The sentence types tested were truthful statements, deceptive statements, and statements written with added cognitive load. Post hoc test results were examined, and statistically significant differences between truthful and deceptive statements, and between truthful statements and statements written under cognitive load, were found. No statistically significant differences were found between deceptive statements and statements written under cognitive load.

Based on the statistical test results for deceptive sentences, the null hypothesis, deceptive sentences will not have left margin spacing variances greater than, or equal to twice previous, or following margins, was rejected. The null hypothesis, deceptive sentences will not have word spacing variances greater than, or equal to twice previous, or following words, was rejected. The null hypothesis, deceptive sentences will not have sentence spacing variances greater than, or equal to twice previous, or following sentences, was rejected. As a result of the statistical tests for truthful sentences, the null hypothesis, truthful sentences will have margin spacing variances greater than, or equal to twice previous, or following margins, failed to be rejected. The null hypothesis, truthful sentences will have word spacing variances greater than, or equal to twice previous, or following words, failed to be rejected. The null hypothesis, truthful sentences will have sentence spacing variances greater than, or equal to twice previous, or following sentences, failed to be rejected.

As noted in the results, both truthful and deceptive sentences contained spacing variances, defined as discrepancies. Through the analysis of the Friedman's two-way ANOVA, the results were confirmed for statistically significant difference between

truthful and deceptive sentences, containing spacing variances. The post hoc test results, including statements written with added cognitive load, were especially noteworthy. The call for research in the deception detection field, regarding the addition of cognitive load, during testing for truthful or deceptive responses, makes these findings especially encouraging for future research (Walczyk, et al., 2013).

Research question 3. Whether or not less mental flexibility, as measured by the CFI, has an effect on a participant's ability to maintain consistent graphological spacing.

The hierarchical multiple regression full model was conducted, and statistically, significant test results were indicated. The full model encompassed the UDS, CFI, BRIEF[®]-A Inhibit and Working Memory scales, and added cognitive load, to further understand the importance of the added IVs. The addition of the CFI scores, to the regression model, resulted in a statistically significant increase for every positive unit, standard deviation changes in the CFI score. The beta weights, from the multiple regression analysis, predicted a positive change in the number of written spacing discrepancies. Based on these results, the null hypothesis, participants scoring lower on the CFI will not reveal more graphological spacing discrepancies than those scoring higher on the CFI, was rejected.

Research question 4. Whether spontaneously produced deceptive writing exhibits variances in graphological spacing.

In the first, two-way ANOVA conducted, the test results were examined, but no interaction effects between spontaneity of writing instructions and the addition of

cognitive load, during writing, were found. Therefore, main effects were interpreted and reported. The results were examined, but no statistically, significant main effect of spontaneously or non-spontaneously written statements, on the spacing discrepancy score, was found. Based on these results, the null hypothesis, participants' deceptive writing will not demonstrate more graphological spacing discrepancies during spontaneous, versus non-spontaneous writing, failed to be rejected.

Research question 5. Whether participants' scores for moral disengagement and unethical work behavior, as measured by the UDS, correlate with graphological spacing discrepancies.

The hierarchical multiple regression full model, was used to find statistically, significant test results. The full model encompassed the UDS, CFI, BRIEF[®]-A Inhibit and Working Memory scales, and added cognitive load, to further understand the importance of the added IVs. The addition of UDS inventory scores to the regression model did not lead to a statistically significant change. Based on these results, the null hypothesis, participants scoring higher on the UDS for moral disengagement and unethical work behavior, will not reveal fewer graphological spacing discrepancies, than those scoring lower on the UDS, failed to be rejected.

Research question 6. Whether written statements void of personal memories show increased graphological discrepancies.

In the second, two-way ANOVA conducted, the test results were examined, but no interaction effects between memory-based writing and the addition of cognitive load, during writing, were found. As a result, main effects were interpreted and reported. No

statistically, significant main effect of memory-based writing, on the spacing discrepancy score, was noted during examination of the results. Based on these results, the null hypothesis, participants' writing based on personal memories, will demonstrate fewer graphological discrepancies, than participants' writing void of personal memories, failed to be rejected.

Research question 7. Whether participants scoring high in the Working Memory and Inhibit domains of the BRIEF[®]-A inventory, will display fewer graphological spacing discrepancies, than those with lower scores in the corresponding domains.

The hierarchical multiple regression full model was used in discovering statistically, significant test results. The full model encompassed the UDS, CFI, BRIEF[®]-A Inhibit and Working Memory scales, and added cognitive load, to further understand the importance of the added IVs. With the addition of the BRIEF[®]-A Inhibit and Working Memory scales, to the regression model, a statistically significant negative change was observed. Based on these results, the null hypothesis, participants scoring high in the BRIEF[®]-A Inhibit and Working Memory domains, will display fewer graphological spacing discrepancies than those with lower scores in the corresponding domains, failed to be rejected.

Summary

The scope of this study included multiple investigations into psycholinguistic behaviors and graphological discrepancies. Through this research, test results were examined and indications were discovered. Psycholinguistic factors, detected in deceptive verbal statements, are carried over into written statements and presented as

graphological spacing discrepancies. Some indirect relationships and correlations, between cognitive and behavioral traits, and graphological spacing discrepancies, were also uncovered. The research methodology was quantitative analysis with stratified sampling. The participants' results were analyzed for statistical significance, using IBM SPSS statistical software.

Friedman's two-way ANOVA by ranks test was used to determine differences in spacing discrepancies between different types of statements. Truthful statements, deceptive statements, and statements written under cognitive load encompassed the statement types tested. Statistically significant differences between left margin spacing discrepancies of truthful sentences and sentences written under cognitive load, as well as deceptive sentences and sentences written under cognitive load were found through post hoc analysis. Statistically significant between-word discrepancies, between truthful and deceptive statements, and between truthful statements and statements written under cognitive load were also discovered, through post hoc analysis.

Of the two-way ANOVAs conducted, there were neither statistically significant interactions found between spontaneity and cognitive load, nor statistically significant interactions found between memory-based writing and cognitive load, on the spacing discrepancy scores. There were statistically significant main effects of cognitive load found on the spacing discrepancy scores for both ANOVA's. These planned comparisons were followed up with post hoc analyses and interpretations for marginal means, denoting the spacing discrepancy scores for cognitive load and no cognitive load, with statistically significant mean differences. Next, the hierarchical multiple regression

full model test results were statistically significant. The full model was composed of the UDS, CFI, BRIEF[®]-A Inhibit and Working Memory scales, and added cognitive load, to further understand the importance of the added IVs.

In Chapter 5, the purpose of the study was revisited, based on the need to fill research gaps in deception detection. The findings, based on statistical analysis of quantitative data, were compared to the existing body of research. Recommendations for future research were noted. In conclusion, implications for social change were explored, based on the results of the research.

Chapter 5: Discussion, Recommendations, and Conclusion

Introduction

The purpose of this quantitative study was to determine whether internally-produced, deceptive psycholinguistic cues would manifest as graphological discrepancies, depending on the scenario's content and context. Written statements were analyzed to explore whether graphological discrepancies manifested through left margin indentions and spaces between words and sentences, to detect deceptive or truthful sentences. Possible interaction effects between spontaneous deceptive influences and cognitive load, and memory-related influences and cognitive load on graphological spacing variances were investigated. Behavioral domain scores and graphological spacing were investigated for possible relationships.

Research participants were law enforcement officers and adult college students, randomly assigned to experimental and control groups. According to instructions, the groups produced truthful or deceptive writing samples, after watching recorded movie clips. To the participants, all directions and stated time limitations appeared randomly assigned. Yet, the directions were predetermined to control the context under which the samples were written. To simulate stresses sometimes found in investigative situations, the experimental groups produced writing samples while experiencing added cognitive load.

Truthful and deceptive handwritten statements were the key IVs. Other IVs included scores from specific cognitive and behavioral domains, along with cognitive load as demonstrated by increased mental demands. The DV was graphological spacing

discrepancies in handwritten statements. A NIST traceable, calibrated caliper was used to measure the graphological spaces in written statements. Friedman's two-way ANOVA, hierarchical multiple regression analysis, and two-way ANOVAs were used to analyze data. Data analysis and graphs were constructed using IBM SPSS statistics software. Psycholinguistic deceptive traits, such as verbal pauses and facial expressions, have been detected in verbal cues and in some nonverbal cues, but whether these deceptive traits carryover and present, as graphological discrepancies in handwritten statements, was unknown (McQuaid et al., 2015). In an effort to fill this gap in research, this quantitative study was conducted.

Key Findings

Possible influences and emotional responses of deceptive behavior were identified through the examination and analysis of graphological spacing discrepancies, found in handwritten statements. All participants were either familiar with or experienced in conducting criminal interrogations or witness interviews. None of the findings were based on being a student versus law enforcement personnel. Statistically significant differences in spacing discrepancies were found between truthful statements, deceptive statements, and statements written under cognitive load. Prior to collecting data and analyzing the results, the extent of the effects of cognitive load in a laboratory setting on graphological spacing were not anticipated. After post hoc analyses were performed and the results were interpreted, statistically significant left margin spacing discrepancies between truthful statements and statements written under cognitive load, and between deceptive statements and statements written under cognitive load, were established. The

alternative hypothesis for Research Question 1, deceptive sentences will have left margin spacing variances greater than or equal to twice the previous or following measured margins, was accepted. The alternative hypothesis for Research Question 2, truthful sentences will lack left margin spacing variances greater than or equal to twice the previous or following measured margins, was not accepted. Additional post hoc analyses and results between-word spacing discrepancies, between truthful and deceptive statements and between truthful statements and statements written under cognitive load, were also established. For Research Questions 1 and 2, the alternative hypotheses, regarding between-word spacing discrepancies, were accepted and not accepted, respectively. The majority of each participant's spacing discrepancies was found between words, so these findings were significant when comparing previous research on verbal deception detection (Lin et al., 2013).

Examinations were made to determine whether there were statistically significant interaction effects between the IV spontaneity of directions and cognitive load, and between the IV memory-related writing and cognitive load. There were no significant interactions found with this population. Statistically significant main effects of cognitive load on the spacing discrepancy score were found in deceptive samples and mixed samples of truthful and deceptive statements. Post hoc analyses were performed on both groups of samples. Statistically significant mean differences were found for spacing discrepancies produced under no cognitive load and produced under cognitive load. Yet, the alternative hypothesis for Research Question 4, participants' deceptive writing will demonstrate more graphological spacing discrepancies during spontaneous versus

nonspontaneous writing was not accepted. Similarly, the alternative hypothesis for Research Question 6, participants' writing based on personal memories will demonstrate fewer graphological discrepancies than participants' writing void of personal memories, was not accepted. Neither alternative hypothesis was written to include the possible effects of cognitive load.

The cognitive and behavioral domain scores, as measured by the UDS, CFI, BRIEF[®]-A Inhibit and Working Memory scales, and added cognitive load, were tested to better understand the importance of added IVs on the DV, spacing discrepancies. These calculations were based on the full model for hierarchical multiple regression. The separate additions of the CFI inventory scores and BRIEF[®]-A Inhibit and Working Memory scales contributed to statistically significant increases of R^2 . When reviewing the inventory scores, these significant changes in R^2 represented the variation in the spacing discrepancy scores. As a result of the participants' individualized writing idiosyncrasies, the coefficients of the regression model were interpreted and reported, not to make predictions, but to possibly explain the graphological spacing variances reported (Nathans et al., 2012). The predictive nature of the alternative hypotheses for Research Questions 3, 5, and 7 were not accepted.

Interpretation of Findings

In recent lie detection experiments, researchers have excluded key aspects of what experts precisely do, in order to detect deception (Levine, 2014). The key factors ignored are listening to and noting the communication's content in relation to context (Levine, 2014). Veracity was the focus, as interpreted by the reader. The context was controlled

by giving directions and time limitations for the participants' responses. Alongside the directives, cognitive load was applied throughout the experiment to simulate normal stressors during an interview or interrogation. In addition to previous lie detection experiments, the knowledge for detecting and differentiating truthful and deceptive written statements through quantitative comparative experiments was expanded, as a result of this study.

In Ekman's hierarchy theory, the significance of the inverse relationship between behavioral leakages and deception cues was explored (Granhag et al., 2015). This study's findings were used to confirm the hierarchy theory through analysis and interpretation of the participants' spacing discrepancy scores in deceptive statements. The participants' behavior and handwriting became more relaxed as the experiment progressed, which may have been attributed to familiarity with the testing procedures and the surroundings. The spacing discrepancy scores increased, as the participants' focused less on their handwriting presentation, and more on describing the movie clips watched, confirming Ekman's theory. These results were observed when comparing the mean spacing discrepancy scores for nonspontaneous versus spontaneous directed writing, with no added cognitive load (see Table 3).

Role-playing, suppressing the truth, and introducing lies are cognitively demanding (Vrij et al., 2011). Deceivers, unlike truth tellers, are typically more concerned with checking their performance and reactions of perceivers (Vrij et al., 2011). The participants in this study did not have the opportunity to judge or alter their performance, based on feedback. A quantitative comparison of the participants' truthful

and deceptive statements in a controlled setting, and under varying cognitive load conditions, was achieved (see Table 2).

The overall emotional influences of truth or deception on writing traits had been previously investigated (Lin et al., 2013; Luria et al., 2014). The current study was used to extend this knowledge by comparing the possible effects of cognitive load on spontaneously directed deceptive statements, and by comparing a blend of truthful and deceptive written statements, based on memories with added cognitive load. The mean spacing discrepancy score for spontaneously directed deceptive statements, with added cognitive load, was greater than the mean spacing discrepancy score for spontaneously directed statements without added cognitive load (see Table 3). These results were expected because cognitive load and spontaneity reduces attempted behavioral control, contributing to increased spacing discrepancy scores (Zuckerman & Driver, 2014). The mean spacing discrepancy scores for truthful and deceptive statements based on memories and without memories, with added cognitive load, were less than the mean spacing discrepancy scores without added cognitive load (see Table 4). These results were possible consequences of the mixed sample of truthful and deceptive statements, the participants' inability to obtain feedback from observers, along with the truth-tellers lack of, or too much concern for, authenticity (Granhag et al., 2015).

Previous researchers used indirect markers for veracity recognition, to recognize the complex courses of emotions and behaviors associated with deception (Cui et al., 2013). One aspect of this study was an exploration of possible relationships, between behavioral domain scores and graphological spacing. Overall, statistically significant

variations in the spacing discrepancy scores were explained by the addition of the CFI and BRIEF[®]-A Inhibit and Working Memory inventory scores. A correlation of participants' mean spacing discrepancy scores to mean CFI and BRIEF[®]-A Inhibit and Working Memory inventory scores was not possible due to the differences between individual spacing discrepancies. Data was collected, and the possibility of multiple contributors to spacing discrepancies was noted as a result of the brain's plasticity and reshaping of human deceptive behaviors (Abe & Greene, 2014).

It is unknown whether psycholinguistic factors have been identified in previous verbal deception detection studies appearing in handwriting (Granhag et al., 2015; McQuaid et al., 2015). In an effort to expand the knowledge of previous research, the current quantitative research was conducted. These data were analyzed for spacing discrepancy locations within the sentences. Spacing discrepancies were noted in locations where individuals often have verbal pauses during conversation. These discrepancies were noted in the three main types of sentences researched, truthful, deceptive, and sentences with added cognitive load (see Table 2).

Interpretations Based on Theoretical Framework

According to Zuckerman's four-factor model, deception involves four behavior-influencing factors, arousal, attempted control, affects associated with deception, and cognitive processing (Zuckerman et al., 1981; Zuckerman & Driver, 2014). Schuetz (2013) refers to handwriting as brainwriting, because handwriting originates with neural impulses from our subconscious. Handwriting lends readers a permanent snapshot of the individual's emotional state. So, when aligned with previous emotional response and

deception theories, handwriting is a nonverbal behavior, expecting to present behavioral leakages (Zuckerman & Driver, 2014).

Arousal. Behavior is sometimes affected by arousal of emotions, occurring during deception (Zuckerman & Driver, 2014). Zuckerman and Driver (2014) noted, in a meta-analysis, communication channels may also form a leakage hierarchy. The majority of leakages occurred within the behaviors of which the deceivers were least aware (Zuckerman & Driver, 2014). Previous researchers also used indirect markers for veracity recognition (Cui et al., 2013). Handwriting, like body language and microexpressions, is a nonverbal behavior, but unlike body and facial expressions, handwriting is a concrete diagnostic tool.

Zuckerman and Driver (2014) also noted deception increases an individual's cognitive load, as he or she tries not to discredit himself or herself. This concept was quantitatively proven in the current study, in both truthful and deceptive statements. Ironically, truth tellers' lack of concern, or too much concern, can seem suspicious (Granhag et al., 2015). Parallel to speech pauses, wider spaces between words and greater left margin indentions were seen in the current study. The wider graphological spaces typically occurred immediately before or after a deceptive word or string of words.

Attempted control. The four-factor model and IDT were written from the perspective, a deceptive person and an observer initiate an interaction (Dunbar et al., 2012). The participants in the current study did not receive feedback or communicate with anyone during testing. For future research, taking writing samples before, during,

and after an interview or interrogation might provide an opportunity to capture the results of behavioral interactions, as referenced in the four-factor model and IDT. Truth tellers' handwriting was also analyzed, since their lack of concern, or too much concern, can seem suspicious (Granhag et al., 2015).

According to the self-presentation theory, researchers suggested a liar's intent to regulate and present behavior, depended on the extent of deception for previous actions (DePaulo & Bond, 2012). For example, more intensive deceptive cues would be noted when an offender's lies referenced actions, identities, or other offenses, as opposed to thoughts and opinions. In the current study, more spacing discrepancies were seen in the narratives, describing false or deceptive actions of characters or descriptive information. Participants in the experimental group wrote narratives about a made-up conversation with a taxi cab driver. Fewer spacing discrepancies were seen in the conversation style narratives, as opposed to the narratives, including descriptive information about times and places.

Affects associated with deception. Unlike most deception theories, the truth default theory is focused on the communication's context and content (Levine, 2014). The current study's design was created to explore the possibility of diagnostic written correspondences. According to the truth default theory, the deceiver creates deceptive statements, when aligning with the observer's expected goal (Levine, 2014). In align with this theory, the current research participants were given directions and expectations, prior to and during the writing exercises. Spontaneous directives and added cognitive load were introduced to the participants throughout the writing exercises, in order to

change goal expectations. Individual discrepancy scores were consistently distinguishable from truthful and deceptive writing, regardless of variations in directives and induced cognitive load.

In previous research on verbal deception detection, differentiations were made between orienting and defensive autonomic responses. Similarities and differences in autonomic responses to lying and concealment of information were explained (Elaad, 2015). The movie clips in the current research study were chosen to evoke behavioral responses, because deceivers' intent to suppress arousal often intensifies behavioral cues (Elaad, 2015; Granhag et al., 2015). As a continuation of this study, future research designs will be created with a focus on the deceiver's tendencies to seclude, rather than orient themselves to the details of the mock crimes.

Following the four-factor model, expectations were observation of similar spacing discrepancies, when referencing the motivation to deceive and the intent to conceal (Zuckerman & Driver, 2014). These expectations were investigated through the use of diverse movie clips and directed participants' responses. The participants were either forced to conceal or to deceive, depending on their individual test directions. Based on individuals' spacing discrepancies, no differences were detected in the number of spacing discrepancies, as they related to concealment or deception. However, there was a change in the number of spacing discrepancies, from truthful to deceptive and words (see Table 2).

Some researchers have viewed only high stakes deception as emotionally arousing, compared to other forms of deception. High stakes deception is typically

presented with opportunities for rehearsal to deceive, leading to malleable emotional responses (Hu, Chen, & Fu, 2012). In the current study, writing exercises were designed to include spontaneous and rehearsed lies, along with scaled cognitive behavioral profiles. The aforementioned was performed in an effort to identify behavioral traits, which were more prevalent during certain types of deception. As a whole, when participants' cognitive flexibility scores were added to the hierarchical multiple regression model, positive changes in discrepancy scores were exhibited. With the addition of participants' BRIEF[®]-A Inhibit and Working Memory scaled scores, negative changes in discrepancy scores were exhibited.

Cognitive processing. Zuckerman and Driver (2014) posited some deceptive behavioral cues may have multiple causes. Determining an exact causal precursor for deception detection is inconceivable. Others believed, creating versus concealing lies was more cognitively demanding, except for good actors and the more intelligent people (Vrij et al., 2011). Following the above theories, an investigation of cognitive traits was conducted to discover, which traits were more conducive to graphological discrepancies in written lies. A direct comparison of the individuals' spacing discrepancy scores and their CFI, UDS, and BRIEF[®]-A Inhibit and Working Memory inventory scores, to other participants' discrepancy and inventory scores, was not possible, due to the unique number of spacing discrepancies for each individual.

Walczyk (2014) proposed most lies to be spontaneous and arising from largely subconscious processes, excluding high stakes lies. Laboratory experiments cannot reproduce high stakes lies experienced in the field. Based on Walczyk's IMT2 theory,

cognitive load was induced, and spontaneity included in the current study, simulating cognitive traits seen in high stakes lies. The results were similar to what would be expected in the field, regarding high stakes lies (see Figure 1). The spacing discrepancy scores for spontaneous, no load statements were less than the non-spontaneous, no load statements. As with high stakes lies, thought processes are more reserved and not subconscious reactions. However, the intent to deceive was apparent in both non-spontaneous and spontaneous statements, when cognitive load was added.

Limitations of the Study

Research participants were chosen, based on their familiarity or working knowledge of deception detection techniques. As a part of the research design, testing occurred at one site, and during one-time block, for each participant group. Unlike random sampling, the stratified sampling guaranteed the inclusion of the preferred participant characteristics. Possible limitations were addressed by conducting a pre-test questionnaire. Participants were asked whether they had any conditions, illnesses, or injuries, preventing or affecting their abilities to compose handwritten responses.

All participants, including those with prior injuries affecting their handwriting, or injuries affecting their memory, completed the writing exercise. No participant's writing samples were excluded from the study. Individual writing and grammar skills did not affect the results, because graphological spacing, not lexical skills, were analyzed for deceptive cues. So, the different writing styles among the more mature officers, compared to the younger students and officers, did not affect the measurement for

spacing discrepancies. The individual's reactions to the directives and their surroundings were indirectly and successfully analyzed through their writing samples.

Most high stakes lies are non-spontaneous (McCornack et al., 2014; Walczyk, 2014). When designing the study, recreating field conditions in laboratory settings, was a major concern. After reviewing the spacing discrepancy results, the concern remains, but from a different point of view. If McCornack et al. (2014) are correct, and deception is an efficient solution to reducing cognitive load, then few spacing discrepancies will be seen in high stakes lies. This may be a limitation when comparing spacing discrepancies of truthful to deceptive sentences.

Initially, the thought was the more complex a person's cognitive moral development was, the less susceptible the person's cognitive moral development was, and the less susceptible the person would be to external influences (Barsky, 2011). Researchers have posited increased cognitive capacity may also increase a person's ability for more sophisticated rationalizations, for deviant behavior (Hystad et al., 2014; Martin et al., 2014). The participant groups chosen for the current research were too similar cognitively to make this comparison. Both the IMT2 and the more recent rationalization theory view deception and cognitive load inversely. According to the four-factor model, fewer spacing discrepancies would be seen in high stakes lies, or with individuals capable of sophisticated rationalizations.

Researchers suggested a lifelong pattern of negative aggressive behavior correlates with impaired verbal working memory (De Brito et al., 2013). Based on this previous correlation, screening questions were asked, about participants' current health

and the ability to compose multiple writing samples. Participants with memory problems, resulting from injuries, did not exhibit higher spacing discrepancy scores for truthful statements, indicative of deceptive behavior. Also, participants scoring high for working memory difficulties, on the BRIEF®-A Working Memory scales, did not have higher spacing discrepancy scores for truthful statements.

Recommendations

Lies result from the need for quick solutions (McCornack et al., 2014). As expected, deception typically arises spontaneously, in normal conversation, except for high stakes lies, requiring sequential planning (McCornack et al., 2014; Walczyk, 2014). Also, McCornack et al. (2014) contend deception reduces cognitive load during conversations. McCornack et al.'s (2014) assertion may not be applicable to handwriting analysis, based on the current research results.

Spacing discrepancy score increases were seen when participants transitioned from truthful to deceptive statements. Cognitive load is also a potential culprit, causing further increases in spacing discrepancies. Increases were seen in spacing discrepancy scores for truthful and deceptive statements with added cognitive load. After running a two-way ANOVA, a decrease in mean spacing discrepancy scores was seen when transitioning from non-spontaneous deceptive statements with no added cognitive load to spontaneous deceptive statements with no added cognitive load, which was opposite of what was initially expected.

Perhaps, this unexpected result was partially due, to only the directions for writing truthful or deceptive statements, were spontaneous. In future research, truthful and

deceptive comparisons will be explored by measuring individual's graphological spacing when writing about a topic, introduced just prior to their writing sample, and writing about a familiar topic, with rehearsed details. According to Ulatowska (2013), liars monitor their speech more aggressively than truth tellers, and liars exhibit overall fewer pauses in their speech, even during spontaneous questioning. McCornack (2014) posited mid-utterance changes in dialogue were normal, because people's perceptions change during cognitive processing. In the current study graphological spacing increases were seen in places where pauses generally occur in speech, such as prior to conjunctions.

By applying the previous research findings to the current study, McCornack's (2014) theory was supported with the current research results, but Ulatowska's (2013) theory was not. Perhaps, Ulatowska's (2013) theory is more applicable to high-stakes lies, not explored in the current research. Further research is warranted to investigate whether contributing factors of cognitive load, such as deception and spontaneity, can be differentiated in all types of deception. Even if factors of cognitive load cannot be differentiated, the current study's results have proven to be indicative of changes within a person's thought processes. Graphological spacing analysis has the potential to become an investigative psychodiagnostic tool.

Implications

The current research method was designed in an effort to encourage continued positive social change among law enforcement officers and the communities they serve. Results from interrogations and interviews are sometimes vague and immaterial. When physical evidence is not available or quick confirmation of information is not possible,

subjective decisions are made, which concomitantly conform to law-based policies and procedures. These decisions may result in what seem like premature closing of criminal cases.

Ideally, criminal investigators' acceptance of this indirect deception detection method may encourage the scientific community, to continue reliability and validity studies of this method, along with other indirect deception detection methods. Advising triers of fact on the strengths and limitations of this research method and existing deception detection theories, may aid in the dissemination of more educated decisions in deception detection. The end goal for this research was to explore and possibly introduce an indirect deception detection method, which may positively impact social relations, fostering trust and support between civilians and the law enforcement community. As a result of the statistically significant research findings, graphological analysis has the potential to be a screening tool for a quantitative indirect method for deception detection.

Communicative behavioral influences sometimes taint witnesses' and suspects' verbal statements, during interviews or interrogations. In theory, setting up a standardized protocol, for screening written statements, should provide more concise and reliable leads, by avoiding biases and behavioral influences, which are unavoidable during verbal communication. Handwriting is directed by the brain and provides an indirect way to map the internal state of a human being (Gupta & Prasad, 2014). Written statements concurrently provide investigators a tangible copy of an individual's untainted thoughts, behavior, and cognitive practices. Identifying deceptive cues should not only

facilitate specification of veracity within statements, but also generate more objective approaches to criminal investigations.

Deception detection methods, using subconscious cognitive receptors are more accurate, than methods using conscious cognitive receptors (ten Brinke et al., 2014). Preventing conscious deliberation of veracity deters stereotyping and biases, which was the approach and intent for the current research method. Theoretically, using subconscious cognitive receptors as the basis for this method, may provide a lens to view, normally concealed, nonverbal behaviors. Identifying deceptive or cognitive load induced cues, may advance productivity of investigations, while contributing to decreased false confession rates.

After further research and standardization of the current research method, analyzing handwritten graphological spaces may provide a psychodiagnostic tool, for supplementing interviews and polygraph examinations. Due to the simplicity of the method, required training for law enforcement personnel would be minimal, for implementation of the psychodiagnostic screening tool. Screening for deceptive cues may serve to reinforce efforts to better uncover false confessions and weak investigative leads, which could contribute to effective community policing. The intention for the research has always been encouragement for continued positive social change among law enforcement and the communities they serve.

Conclusion

The implications for positive social change, as a result of the current research could be significant. When citizens perceive police investigations as competent and fair,

the citizens are more willing to identify and cooperate with law enforcement.

Researchers identify behavioral fluxes in interrogations and interviews, to answer questions about the verification of senders' emotions and confidence in their statements (Ulatowska, 2014). As a result of this research, identifying graphological discrepancies as an indirect deception detection method may prove to provide the same answers, along with tangible evidence.

Prior to this research study, verbal and nonverbal communication variations, resulting from cognitive load and emotional influences, had been researched (Lin et al., 2013; Luria et al., 2014). However, the possible transfer of psycholinguistic cues, from verbal to written communication, had not been confirmed (Granhag et al., 2015; McQuaid et al., 2015). This quantitative research study was an exploration whether internally-produced, deceptive psycholinguistic cues, depending on the scenario's content and context, manifested as graphological discrepancies. Lin et al.'s (2013) appeal for quantitative analysis of deceptive written statements, produced under cognitive load in varying contexts, was investigated in this study.

In future studies, exploration of the method's reliability for deception detection will continue for low and high stakes lies, along with concealment of information. Hartwig and Bond's (2014) suggestion, deception detection remains stable from multiple cues across various content and contexts, will be investigated by comparing truthful and deceptive verbal and written statements. Gaining a better understanding of the idiosyncrasies in deceptive writing and the influences of cognitive load on handwriting, was established in this research study. As a result of this research, graphology as a

psychodiagnostic method for deception detection was proven, as a potential method to complement interviews and interrogations.

References

- Abe, N., & Greene, J. (2014). Response to anticipated reward in the nucleus accumbens predicts behavior in an independent test of honesty. *The Journal of Neuroscience*, *34*(32), 10564-10572. doi:10.1523/JNEUROSCI.0217-14.2014
- Alloway, T., McCallum, F., Alloway, R., & Hoicka, E. (2015). Liar, liar, working memory on fire: Investigating the role of working memory in childhood verbal deception. *Journal of Experimental Child Psychology*, *137*, 30-38. doi:10.1016/j.jecp.2015.03.013
- Almela, A., Valencia-Garcia, R., & Cantos, P. (2013). Seeing through deception: A computational approach to deceit detection in Spanish written communication. *Linguistic Evidence in Security, Law & Intelligence*, *1*(1), 3-12. doi:10.5195/lesli.2013.5
- Aviezer, H., Trope, Y., & Todorov, A. (2012). Holistic person processing: Faces with bodies tell the whole story. *Journal of Personality and Social Psychology*, *103*(1), 20-37. doi:10.1037/a0027411
- Balestrino, M., Fontana, P., Terzuoli, S., Volpe, S., Inglese, M., & Cocito, L. (2012). Altered handwriting suggests cognitive impairment and may be relevant to posthumous evaluation. *Journal of Forensic Sciences*, *57*(5), 1252-1258. doi:10.1111/j.1556-4029.2012.02131.x
- Bandura, A. (1999). Moral disengagement in the perpetration of inhumanities. *Personality & Social Psychology Review*, *3*(3), 193-209. doi:10.1207/s15327957

pspr0303_3

- Barsky, A. (2011). Investigating the effects of moral disengagement and participation on unethical work behavior. *Journal of Business Ethics, 104*(1), 59-75.
doi:10.1007/s10551-011-0889-7
- Baskin, D., & Sommers, I. (2012). The influence of forensic evidence on the case outcomes of assault and robbery incidents. *Criminal Justice Policy Review, 23*(2), 186-210. doi:10.1177/0887403410395576
- Bell, J.E. (1951). [Review of the book *Handwriting analysis as a psychodiagnostic tool: A study in general and clinical graphology*, by U. Sonneman]. *The Journal of Abnormal and Social Psychology, 46*(3), 445-447. doi:10.1037/h0050745
- Berninger, V.W., Vaughan, K.B., Abbott, R.D., Abbott, S.P., Rogan, L.W., Brooks, A., & Graham, S. (1997). Treatment of handwriting problems in beginning writers: Transfer from handwriting to composition. *Journal of Educational Psychology, 89*(4), 652-667. doi:10.1037/00022-0663.89.4.652
- Bogaard, G., Meijer, E.H., Vrij, A., Broers, N.J., & Merckelbach, H. (2014). SCAN is largely driven by 12 criteria: Results from sexual abuse statements. *Psychology, Crime, & Law, 20*(5), 430-449. doi:10.1080/1068316X.2013.793338
- Bond, C., Howard, A., Hutchison, J., & Masip, J. (2013). Overlooking the obvious: Incentives to lie. *Basic and Applied Social Psychology, 35*(2), 212-221.
doi:10.1080/01973533.2013.764302
- Bradford, B. (2014). Policing and social identity: Procedural justice, inclusion and cooperation between police and public. *Policing and Society, 24*(1), 22-43.

doi:10.1080/10439463.2012.724068

- Bradley, N. (2011). Graphology: A tool for marketing? *Marketing Review*, 11(2), 103-115. doi:10.1362/146934711X589354
- Bublitz, J., & Merkel, R. (2014). Crimes against minds: On mental manipulations, harms and a human right to mental self-determination. *Criminal Law and Philosophy*, 8(1), 51-77. doi:10.1007/s11572-012-9172-y
- Burgoon, J., Schuetzler, R., & Wilson, D. (2014). Kinesic patterning in deceptive and truthful interactions. *Journal of Nonverbal Behavior*, 39(1), 1-24.
doi:10.1007/s10919-014-0190-4
- Byrne, J.M. (2014). The future of justice reinvestment: Assessing the merits of individual and community change strategies. *Victims and Offenders*, 9(1), 1-5.
doi:10.1080/15564886.2014.864509
- Chung, C., & Pennebaker, J. (2014). Counting little words in big data: The psychology of communities, culture, and history. *Social Cognition and Communication*, 25-42.
Retrieved from <http://real.mtak.hu/20194/16/PennebakerEASP2012.pdf>
- Creswell, J. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th Ed.) Thousand Oaks, CA: Sage Publications, Inc.
- Cui, Q., Vanman, E.J., Wei, D., Yang, W., Jia, L., & Zhang, Q. (2013). Detection of deception based on fMRI activation patterns underlying the production of a deceptive response and receiving feedback about the success of the deception after a mock murder crime. *Social Cognitive and Affective Neuroscience*. 9(10). 1472-1480. doi:10.1093/scan/nst134

- De Brito, S.A., Viding, E., Kumari, V., Blackwood, N., & Hodgins, S. (2013). Cool and hot executive function impairments in violent offenders with antisocial personality disorder with and without psychopathy. *PLoS ONE*, 8(6). doi:10.1371/journal.pone.0065566
- Debey, E., De Houwer, J., & Verschuere, B. (2014). Lying relies on the truth. *Cognition*, 132(3), 324-334. doi:10.1016/j.cognition.2014.04.009
- Dennis, J.P., & Vander Wal, J.S. (2010). The Cognitive Flexibility Inventory: Instrument development and estimates of reliability and validity. *Cognitive Therapy and Research*, 34, 241-253. doi:10.1007/s10608-009-92764.
- DePaulo, B.M., & Bond Jr., C. (2012). Beyond accuracy: Bigger, broader ways to think about deceit. *Journal of Applied Research in Memory and Cognition*, 1(2), 120-121. doi:10.1016/j.jarmac.2012.04.010
- Downey, J.E. (1911). Graphic functions. *Psychological Bulletin*, 8(9), 311-317. doi:10.1037/h0073727
- Dunbar, N.E., Jensen, M.L., Bessarabova, E., Burgoon, J.K., Bernard, D.R., Harrison, K.J., ...Eckstein, J.M. (2012). Empowered by persuasive deception: The effects of power and deception on dominance, credibility, and decision making. *Communication Research*, 41(6), 852-876. doi:10.1177/0093650212447099
- Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion Review*, 3(4), 364-370. doi:10.1177/1754073911410740
- Elaad, E. (2015). Cognitive and emotional aspects of polygraph diagnostic procedures: A comment on Palmatier and Rovner 2015. *International Journal of*

Psychophysiology.95, 14-15. doi:10.1016/j.ijpsycho.2014.07.011

Evans, A., & Lee, K. (2011). Verbal deception from late childhood to middle adolescence and its relation to executive functioning skills. *Developmental Psychology*, 47(4), 1108-1116. doi:10.1037/a0023425

Farah, M., Hutchinson, J., Phelps, E., & Wagner, A. (2014). Functional MRI based lie detection: Scientific and societal challenges. *Nature Reviews Neuroscience*, 15(2), 123-131. doi:10.1038/nrn3665

Field, A.P. (2013). *Discovering statistics using IBM SPSS statistics and sex and drugs and rock "n" roll*. London, UK: SAGE Publications , Inc.

Frankfort-Nachmias, C., & Leon-Guerrero, A. (2015). *Social statistics for a diverse society*. Thousand Oaks, CA: SAGE Publications, Inc.

Franklin, S., Madl, T., D’Mello, S., & Snider, J. (2014). LIDA: A systems-level architecture for cognition, emotion, and learning. *IEEE Transactions on Autonomous Mental Development*, 6(1), 19-41.
doi:10.1109/TAMD.2013.2277589

Fuller, C.M., Biros, D.P., & Delen, D. (2011). An investigation of data and text mining methods for real world deception detection. *Expert Systems with Applications*, 38(7), 8392-8398. doi: 10.1016/j.eswa2011.01.032

Ganis, G., & Rosenfeld, J.P. (2011). Neural correlates of deception. In J. Illes & B.J. Sahakian (Eds.), *Oxford Handbook of Neuroethics* (pp. 101-118). Oxford, UK: Oxford University Press.

García-Higuera, J., Crivelli, C., & Fernández-Dols, J. (2015). Facial expressions during

- an extremely intense emotional situation: Toreros' lip funnel. *Social Science Information*, 54(4), 439-454. doi: 10.1177/0539018415596381
- Goldman-Eisler, F. (1958). Speech production and the predictability of words in context. *Quarterly Journal of Experimental Psychology*, 10(2), 96-106.
doi:10.1080/17470215808416261
- Granhag, P., Verschuere, B., & Vrij, A. (2015). *Detecting deception: Current challenges and cognitive approaches*. West Sussex, UK: Wiley-Blackwell.
- Gupta, S., & Prasad, S. (2014,). Human signature psychology relation: A time-series analysis. In *Association for Computing Machinery. Proceedings of the International Conference on Information and Communication Technology for Competitive Strategies (2)*. New York, NY: ACM. doi:10.1145/2677855.2677857
- Hartwig, M., & Bond, C.F. (2011). Why do lie-catchers fail? A lens model meta-analysis of human lie judgments. *Psychological Bulletin*, 137(4), 643-659.
doi:10.1037/a0023589
- Hartwig, M., & Bond, C.F. (2014). Lie detection from multiple cues: A meta-analysis. *Applied Cognitive Psychology*, 28(5), 661-676. doi:10.1002/acp.3052
- Hartwig, M., Voss, J., & Wall, D. (2015). Detecting lies in the financial industry: A survey of investment professionals' beliefs. *Journal of Behavioral Finance*, 16(2), 173-182. doi: 10.1080/15427560.2015.1034862
- Hauch, V., Blandón-Gitlin, I., Masip, J., & Sporer, S.L. (2012). Linguistic cues to deception assessed by computer programs: A meta-analysis. In *EACL 2012*

Workshop on Computational approaches to Deception Detection. Avignon, France: Association for computational Linguistics. Retrieved from:
<http://dl.acm.org/citation.cfm?id=2388617>

Haveripeth, P.D. (2013). The use of examination of questioned documents. *International Journal of Innovative Research and Development*, 2(3), 592-606. Retrieved from
<http://ojms.cloudapp.net/index.php/ijird/article/view/35359>

Hu, X., Chen, H., Fu, G. (2012). A repeated lie becomes a truth? The effect of intentional control and training on deception. *Frontiers in Psychology*, 3(488), 1-7.
doi:10.3389/fpsyg.2012.00488

Hystad, S.W., Mearns, K.J., & Eid, J. (2014). Moral disengagement as a mechanism between perceptions of organizational injustice and deviant work behaviors. *Safety Science*, 68, 138-145. doi:10.1016/j.ssci.2014.03.012

Jacob, H., Kreifelts, B., Brück, C., Nizielski, S., Schütz, A., & Wildgruber, D. (2012). Nonverbal signals speak up: Association between perceptual nonverbal dominance and emotional intelligence. *Cognitive & Emotion*, 27(5), 1-17.
doi:10.1080/02699931.2012.739999

Kirchhübel, C., & Howard, D.M. (2013). Detecting suspicious behavior using speech: Acoustic correlates of deceptive speech-An exploratory investigation. *Applied Ergonomics*, 44(5), 694-702. doi:10.1016/j.apergo.2012.04.016

Koppl, R., & Sacks, M. (2013). The criminal justice system creates false incentives for false convictions. *Criminal Justice Ethics*, 32(2), 126-162.
doi:10.1080/0731129X.2013.817070

- Kučera, D., & Havigerová, J. (2011). Handwriting in diagnostic perspective. *E-Psychologie*, 5(2-3), 1-8. Retrieved from <http://www.e-psycholog.eu/pdf/kucera-havigerova.pdf>
- Laerd Statistics (2015). *Statistical tutorials and software guides*. Retrieved from <https://statistics.laerd.com/>
- Langleben, D., & Moriarty, J. (2013). Using brain imaging for lie detection: Where science, law, and policy collide. *Psychology, Public Policy, and Law*, 19(2), 222-234. doi:10.1037/a0028841
- Levine, T.R. (2014). Truth-Default Theory (TDT): A theory of human deception and deception detection. *Journal of Language and Social Psychology*, 33(4), 378-392. doi:10.1177/0261927X14535916
- Lin, T., Xie, T., Chen, Y., & Tang, N. (2013). Automatic cognitive load evaluation using writing features: An exploratory study. *International Journal of Industrial Ergonomics*, 43(3), 210-217. doi:10.1016/j.ergon.2013.02.002
- Luria, G., Kahana, A., & Rosenblum, S. (2014). Detection of deception via handwriting behaviors using a computerized tool: Toward an evaluation of malingering. *Cognitive Computation*, 6(4), 849-855. doi:10.1007/s12559-014-9288-6
- Martin, S., Kish-Gephart, J., Detert, J. (2014). Blind forces ethical infrastructures and moral disengagement in organizations. *Organizational Psychology Review*, 4(4), 295-325. doi:10.1177/2041386613518576
- Masip, J., Bethencourt, M., Lucas, G., Sánchez-San Segundo, M., & Herrero, C. (2012). Deception detection from written accounts. *Scandinavian Journal of Psychology*,

53(2), 103-111. doi:10.1111/j.1467-9450.2011.00931.x

McCornack, S. (2015). Deceptive message production. In C. Berger, M. Roloff, S.

Wilson, J. Dillard, J. Caughlin, & D. Solomon (Eds.), *The International*

Encyclopedia of Interpersonal Communication (pp 1-5).

doi:10.1002/9781118540190

McCornack, S.A., Morrison, K., Paik, J.E., Wisner, A.M., & Zhu, X. (2014). Information

Manipulation Theory 2: A propositional theory of deceptive discourse production.

Journal of Language and Social Psychology, 33(4), 348-377.

doi:10.1177/0261927X14534656

McQuaid, S., Woodworth, M., Hutton, E., Porter, S., & ten Brinke, L. (2015). Automated

insights: Verbal cues to deception in real-life high-stakes lies. *Psychology, Crime*

& Law, 21(7), 617-631. doi:10.1080/1068316X.2015.1008477

Morgan, C.A., Colwell, K., & Hazlett, G. A. (2011). Efficacy of forensic statement

analysis in distinguishing truthful from deceptive eyewitness accounts of highly stressful events. *Journal of Forensic Sciences*, 56(5), 1227-1234.

doi:10.1111/j.1556-4029.2011.01896.x

Nahari, G., Vrij, A., & Fisher, R.P. (2012). Does the truth come out in the writing?

SCAN as a lie detection tool. *Law & Human Behavior*, 36(1), 68-76.

doi:10.1037/h0093965

Nathans, L., Oswald, F., & Nimon, K. (2012). Interpreting multiple linear regression: A

guidebook of variable importance. *Practical Assessment, Research and*

Evaluation, 17(9), 1-19. Retrieved from <http://pareonline.net/pdf/v17n9.pdf>

- Pennebaker, J.W. (2011). The secret life of pronouns. *New Scientist*, 211(2828), 42-45.
doi:10.1016/S0262-4079(11)62167-2
- Porter, S., ten Brink, L., & Wallace, B. (2012). Secrets and lies: Involuntary leakage in deceptive facial expressions as a function of emotional intensity. *Journal of Nonverbal Behavior*, 36(1), 23-37. doi:10.1007/s10919-011-0120-7
- Raine, A. (2013). *The anatomy of violence: The biological roots of crime* (1st ed.). New York, NY: Vintage Books.
- Roth, R.M., Isquith, P.K., & Gioia, G.A. (2005). *Behavior Rating Inventory of Executive Function*[®]-Adult Version professional manual. Lutz, FL: PAR.
- Ruffman, T., Murray, J., Halberstadt, J., & Vater, T. (2012) Age-related differences in deception. *Psychology and Aging*, 27(3), 543-549. doi:10.1037/a0023380
- Saudek, R. (1931). Writing movements as indications of the writer's social behavior. *The Journal of Social Psychology*, 2, 337-373. doi:10.1080/00224545.1931.9918979
- Saudek, R. (1934). Can different writers produce identical handwritings? *Journal of Personality*, 2(3), 231-245. doi:10.1111/j.1467-6494.1934.tb02099.x
- Schuetz, L. (2013, Fall). Re: Graphological portrait of isolation: Emily Dickerson and today's society: How we move on paper is symbolic [Web log message]. Retrieved from [http://www.depthinsights.com/Depth-Insights-scholarly-ezine/e-zin Ce-issue-5-fall-2013/graphological-portrait-of-isolation-emily-dickinson-and-todays-society-by-lisa-schuetz/](http://www.depthinsights.com/Depth-Insights-scholarly-ezine/e-zin-Ce-issue-5-fall-2013/graphological-portrait-of-isolation-emily-dickinson-and-todays-society-by-lisa-schuetz/)
- Sonneman, U. (1953). *Handwriting analysis as a psychodiagnostic tool*. New York City, NY: Grune & Stratton, Inc.

- Stangor, C. (2015). *Research methods for the behavioral sciences*. Stamford, CT: Cengage Learning.
- Stein-Lewinson, T. (1938). An introduction to the graphology of Ludwig Klages. *Journal of Personality*, 6(3), 163-176. doi:10.1111/j.1467-6494.1938.tb02251.x
- Tang, T. (2012). Detecting honest people's lies in handwriting: The power of the Ten Commandments and internalized ethical values. *Journal of Business Ethics*, 106(4), 389-400. doi:10.1007/s10551-011-1015-6
- ten Brinke, L., MacDonald, S., Porter, S., & O'Connor, B. (2012). Crocodile tears: Facial, verbal and body language behaviours associated with genuine and fabricated remorse. *Law and Human Behavior*, 36(1), 51-59. doi:10.1037/h0093950
- ten Brinke, L., Stimson, D., & Carney, D. (2014). Some evidence for unconscious lie detection. *Psychological Science*, 25(5), 1098-1105. doi:10.1177/0956797614524421
- Ulatowska, J. (2013). Indicators of deception in different lie scenarios. *Annals of Psychology*, 16(1), 127-146. Retrieved from www.ceeol.com
- Ulatowska, J. (2014). Different questions – different accuracy? The accuracy of various indirect question types in deception detection. *Psychology, Psychiatry, and Law*, 21(2), 231-240. doi:10.1080/13218719.2013.803278
- Visu-Petra, G., Miclea, M., Buş, I., Visu-Petra, L. (2014). Detecting concealed information: The role of individual differences in executive functions and social desirability. *Psychology, Crime & Law*, 20(1), 20-36. doi: 10.1080/1068316X.

2012.736509

- Volz, K., Vogeley, K., Tittgemeyer, M., von Cramon, D., & Sutter, M. (2015). The neural basis of deception in strategic interactions. *Frontiers in Behavioral Neuroscience, 9*(27), 1-12. doi:10.3389/fnbeh.2015.00027
- Vrij, A., & Granhag, P.A. (2012). Eliciting cues to deception and truth: What matters are the questions asked. *Journal of Applied Research in Memory and Cognition, 1*(2), 110-117. doi:10.1016/j.jarmac.2012.02.004
- Vrij, A., Granhag, P.A., Mann, S., & Leal, S. (2011). Outsmarting the liars: Toward a cognitive lie detection approach. *Current Directions in Psychological Science, 20*(1), 28-32. doi:10.1177/0963721410391245
- Vytal, K.E., Cornwell, B. R., Letkiewicz, A.M., Arkin, N.E., & Grillon, C. (2013). The complex interaction between anxiety and cognition: Insight from spatial and verbal working memory. *Frontiers in Human Neuroscience, 7*, 315-325. doi:10.3389/fnhum.2013.00093
- Walczyk, J.J. (2014). A commentary on Information Manipulation Theory 2: Its place in deception research and suggestions for elaboration. *Journal of Language and Social Psychology, 33*(4), 424-430. doi:10.1177/0261927X14535395
- Walczyk, J.J., Igou, F.P., Dixon, A.P., & Tcholakian, T. (2013). Advancing lie detection by inducing cognitive load on liars: A review of relevant theories and techniques guided by lessons from polygraph-based approaches. *Frontiers in Psychology, 4*, 14. doi:10.3389/fpsyg.2013.00014
- Wilcox, R. (2012). *Introduction to robust estimation and hypothesis testing* (3rd ed.).

Waltham, MA: Elsevier.

- Willén, R.M., & Strömwall, L.A. (2012). Offenders' uncoerced false confessions: A new application of statement analysis? *Legal & Criminological Psychology, 17*(2), 346-359. doi:10.1111/j.2044-8333.2011.02018.x
- Yerkes, R.M., & Dodson, J.D. (1908). The relation of strength of stimulus to rapidity of habit-formation. *Journal of Comparative Neurology and Psychology, 18*(5), 459-482. doi:10.1002/cne.92018050
- Yan, W., Wu, Q., Liu, Y., Wang, S., & Fu, X. (2013, April). CASME database: A dataset of spontaneous micro-expressions collected from neutralized faces. Paper presented at the Automatic Face and Gesture Recognition (FG), 2013 10th IEEE International Conference and Workshops, Shanghai.
- Yu, K., Epps, J., & Chen, F. (2011). Cognitive load evaluation of handwriting using stroke-level features. In *IUI 2011 Proceedings of the 16th International Conference on Intelligent User Interfaces*. New York, NY: Association for Computing Machinery. Retrieved from <http://dl.acm.org/citation.cfm?id=2388617>
- Zhang, Z., Liu, C., & Zhao, M. (2015). A sparse projection and low-rank recovery framework for handwriting representation and salient stroke feature extraction. *ACM Transactions on Intelligent Systems and Technology, 6*(1), 1-26. doi:10.1145/2601408
- Zuckerman, M., DePaulo, B.M., & Rosenthal, R. (1981). Verbal and nonverbal communication of deception. In L. Berkowitz (Ed.), *Advances in experimental*

and social psychology (pp 1-59). New York, NY: Academic Press.

Zuckerman, M., & Driver, R.E. (2014). Telling lies: Verbal and nonverbal correlates of deception. In A. Siegman & S. Feldstein (Eds.), *Multichannel integrations of nonverbal behavior* (pp. 129-147). New York, NY: Psychology Press.

Appendix A: Permission Letter for Cognitive Flexibility Inventory

From:

Date: Tue, Mar 3, 2015 at 4:02 PM

Subject: Re: CFI - Permission to use your test

To: Michelle Doscher

Hi Michelle,

You have my permission to the use the measure. See attached. Good luck with your research!

3 Attachments

[Preview attachment CFI measure.pdf](#)



[Preview attachment CFI scoring instructions.docx](#)



[Preview attachment CFI pilot manuscript.pdf](#)



Appendix B: Permission Letter for Unethical Deception Scale

from:

to: Michelle Doscher

date: Thu, Jan 22, 2015 at 7:56 PM

subject: Re: Permission to use your Unethical Deception Scale

mailed-by: unimelb.edu.au

You absolutely have my permission. Good luck with your study.

Cheers,

Appendix C: Measuring Protocol

Scope

This measuring protocol is for anyone measuring graphological spacing surrounding left margins, between words, and between sentences. This protocol explains how to measure graphological spaces with an electronic caliper. This protocol does not cover how to determine graphological spacing discrepancies.

Task Description

- A National Institute of Standards and Technology, traceable, calibrated digital caliper was used for all measurements.
- Completely close the caliper. Set the units of measurement to millimeters.
- Zero the caliper.
- Check calibration against a calibrated stainless steel ruler.
- All measurements were measured to two decimal places, using the external measuring jaws.
- To measure a space, slide the caliper open until the left jaw touches the farthest right side of a letter, and the right jaw touches the closest left side of a letter. Read and record the measurement.
- Repeat and record the measurement.
- Measure all spaces between words and sentences. Record results above the spaces.
- To measure left margins, for indented or block paragraphs, use a squared ruler to draw a vertical line perpendicular to the bottom of the page, starting at the far left edge of the first non-indented line.
- Measure the difference between the beginning of each line and the vertical line. Read and record the absolute value of each measurement.
- Repeat and record the measurements for each line in the paragraph.

Revised 12/13/15