

EFFECTS OF MOTIVATION AND ITEM DIFFICULTY ON OCULOMOTOR AND
BEHAVIORAL MEASURES OF DECEPTION

by

Andrea K Webb

A dissertation submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

Department of Educational Psychology

The University of Utah

September 2008

Copyright © Andrea K Webb

All Rights Reserved

ABSTRACT

Guilt, motivation, and item difficulty were manipulated in the present study to determine their effects on oculomotor and behavioral measures of deception. Fifty-six subjects were in the guilty condition and stole \$20 from a secretary's purse. Another 56 subjects were innocent and did not steal anything. All subjects were told that some subjects had to download an exam from a professor's computer, but in actuality, no one committed that crime. Half of the subjects were offered a \$30 bonus if they could convince the examiner of their innocence, and the remaining subjects were offered a \$1 bonus. Subjects answered 48 true/false items five times while their eye movements and pupil diameter were recorded. Sixteen items pertained to the theft of the \$20, 16 pertained to the theft of the exam, and 16 were neutral items. Half of the subjects answered a mixed set of difficult and easy true/false items and half answered only easy items. Subjects completed a Stroop task after answering the true/false items to test a self-regulatory depletion hypothesis. Subjects then were interviewed to assess strategies they may have used to appear innocent on the test.

Guilty subjects showed the largest pupil diameter while reading the cash items. Guilty subjects took longer to respond, made more fixations, and did more reading and rereading when answering the exam and neutral items. Innocent subjects did not show as large a difference among the three item types as did the guilty subjects. A weighted combination of four variables that were diagnostic of deception correctly classified 84%

of guilty subjects and 89% of innocent subjects. Contrary to predictions derived from the self-regulatory depletion hypothesis, there were no main effects of guilt, motivation, or item difficulty on Stroop response time or accuracy. Subject responses in the interview indicated that they tried to be consistent in how they read and answered the items and took their time when answering the neutral items.

TABLE OF CONTENTS

ABSTRACT	iv
LIST OF FIGURES	viii
LIST OF TABLES	ix
ACKNOWLEDGMENTS	xi
Chapter	
1. INTRODUCTION	1
Pupil Diameter	2
Eye Blinks.....	4
Motivation	4
Item and Task Difficulty	6
Trait Self-Control and Achievement Motivation.....	7
Summary.....	8
Objectives	9
2. METHOD	11
Subjects.....	11
Design.....	13
Apparatus.....	13
Materials	14
Procedure.....	18
Dependent Measures	22
3. RESULTS.....	25
Manipulation Check	25
Objective 1: Effects of Guilt, Motivation, and Item Difficulty on T/F Items	26
Objective 2: Classification of Guilty and Innocent Subjects.....	42
Objective 3: Effects of Self-Control and Achievement Motivation	49
Objective 4: Effects of Guilt, Motivation, and Item Difficulty on Stroop RT and Accuracy.....	51

Interview Questions.....	54
4. DISCUSSION.....	57
Limitations.....	62
Implications and Future Directions.....	63
Summary.....	64
Appendices	
A. T/F ITEMS	65
B. DEMOGRAPHIC QUESTIONNAIRE	70
C. SELF-CONTROL SCALE.....	73
D. CASSIDY-LYNN ACHIEVEMENT MOTIVATION QUESTIONNAIRE	75
E. MARLOWE-CROWNE SOCIAL DESIRABILITY SCALE	78
F. INTERVIEW QUESTIONS.....	81
G. EFFECT SIZES FOR EACH DEPENDENT VARIABLE	83
REFERENCES.....	114

LIST OF FIGURES

Figure	Page
1. Guilt by question type interaction for RT	31
2. Guilt by item difficulty interaction for proportion wrong.....	32
3. Guilt by question type interaction for number of fixations.....	33
4a. Guilt by question type interaction for number of fixations for low motivation group.....	34
4b. Guilt by question type interaction for number of fixations for high motivation group.....	35
5. Guilt by question type interaction for first pass duration.....	36
6. Guilt by question type interaction for reread duration.....	37
7a. Guilt by question type by time interaction for PD for guilty subjects	38
7b. Guilt by question type by time interaction for PD for innocent subjects.....	39
8. Guilt by question type interaction for next item blink rate	41
9. Guilt by achievement motivation interaction for the difference Between cash and exam items for RT.....	50
10a. Stroop RT item difficulty by motivation interaction for females	52
10b. Stroop RT item difficulty by motivation interaction for males.....	53

LIST OF TABLES

Table	Page
1. Means, Standard Deviations, and Ranges for Age, GPA, Self-control, Achievement Motivation and Marlowe-Crowne	11
2. Frequencies and Percentages for Categorical Demographic Questions	12
3a. Means (and Standard Deviations) for the Dependent Variables by Motivation, Item Difficulty, and Question Type for Guilty Subjects.....	28
3b. Means (and Standard Deviations) for the Dependent Variables by Motivation, Item Difficulty, and Question Type for Innocent Subjects	29
4. Point-biserial Correlations (and Reliabilities) for Easy and Mixed Item Difficulty Conditions	44
5. Point-biserial Correlations by Repetition for the Eight Variables Selected for Possible Inclusion in the Discriminant Function	46
6. Intercorrelations Among the Eight Variables Selected for Possible Inclusion in the Discriminant Function.....	47
7. Standardized Canonical Discriminant Function Coefficients	48
8. Functions at Group Centroids.....	48
9. Frequencies (and Percentages) of Cases Correctly Classified with the Linear Discriminant Function.....	48
10. Frequencies (and Percentages) of Cases Correctly Classified with the Linear Discriminant Function Using Variables from Cook et al. (2008)	49
11. Effect Sizes for Response Time.....	84
12. Effect Sizes for Proportion Wrong	87
13. Effect Sizes for Number of Fixations	90

14. Effect Sizes for First Pass Duration.....	93
15. Effect Sizes for Reread Duration.....	96
16. Effect Sizes for Pupil Diameter.....	99
17. Effect Sizes for Item Blink Rate.....	104
18. Effect Sizes for Next Item Blink Rate	107
19. Effect Sizes for Stroop Response Time	110
20. Effect Sizes for Stroop Proportion Wrong.....	112

ACKNOWLEDGMENTS

This research was funded in part by a dissertation award from the American Psychological Association.

This project would not have been possible without the support and encouragement of several people. First, a huge thank you to my mentor and advisor, John Kircher. John spent countless patient hours with me discussing the project design, procedures, and results. I also am extremely grateful to John for providing most of the financial support for this project, and for providing me with funding for all of my years of graduate work. I also am extremely grateful for the opportunity and privilege I have had to work with John throughout my graduate education.

I also would like to thank all of my committee members for their insights and support throughout the many stages of this project. I am grateful that John, Anne, Doug, and Dan allowed me to expand on their original idea with this project.

Third, I would like to thank Adrienne Splinter for her numerous hours of hard work scheduling all of my subjects for this project. This project could not have been completed without her work and dedication.

I also would like to thank Sherrill Christensen for ensuring that I met all of the requirements for graduation and for celebrating all of the milestones of the project with me.

Finally, I would like to thank my family, especially my husband Brian, for supporting me through all of the highs and lows inherent in completing a dissertation and attending graduate school. I could not have completed my degree without their love, support, and understanding.

CHAPTER 1

INTRODUCTION

The polygraph is used by many government agencies to assist adjudicators in making employee retention and hiring decisions. Although the polygraph can be a useful tool in these situations (Krapohl, 2002), the National Research Council (2003) recently published a report that questioned the validity of the polygraph and its utility as a security screening tool and called for the development of new security screening techniques.

A problem with the polygraph is that it relies on emotional responses to test stimuli that are nonspecific and habituate. To address some of these concerns, Cook et al. (2008) developed a cognition-based deception test that may be of value in screening contexts. In the Cook et al. study, subjects committed one of two mock-crimes or were innocent of both crimes. One group of guilty subjects stole \$20 from a secretary's purse. Another group of guilty subjects downloaded credit card information from a graduate student's computer. All subjects were fitted with an eye tracker and answered true/false (T/F) items on a computer screen. There were three categories of items: items that pertained to the theft of the \$20, items that pertained to the theft of the credit card information, and neutral items. Including questions about multiple issues allowed Cook et al. to simulate a security screening situation. In screening situations, multiple issues are addressed, and the person may or may not be deceptive about one or more issues on the test. Dependent measures included number of fixations made on an item, first pass

duration (time spent reading an item), second pass duration (time spent rereading an item), and pupil diameter (PD).

In the Cook et al. (2008) study, some of the results were consistent with predictions, whereas others were not. Cook et al. expected subjects to show more fixations, more reading and rereading, and larger PD when reading items that pertained to the crime they committed. Subjects did show larger PD on items pertaining to the crime they committed, suggesting that they engaged in effortful processing of those items. However, for number of fixations, first pass duration, and second pass duration, guilty subjects made more fixations and spent more time reading and rereading items that pertained to the crime they *did not* commit. The same pattern was seen for both groups of guilty subjects. These results were unexpected. One of the goals of the present study was to determine if the unanticipated pattern of results observed by Cook et al. could be replicated.

Pupil Diameter

Pupil diameter was one of the primary dependent variables of interest in the present study. Decades of research have demonstrated that changes in PD are reliable and valid indicators of cognitive effort. Increases in pupil diameter are associated with task difficulty in mental multiplication (Ahern & Beatty, 1979; Hess & Polt, 1964), recall and transformation of digit strings (Kahneman & Beatty, 1966), letter processing (Beatty & Wagoner, 1978), sentence processing (Just & Carpenter, 1993; Schluroff, 1982), and lexical translation (Hyona, Tommola, & Alaja, 1995). Cook et al. (2008) found PD to be a reliable indicator of deception, which is consistent with the idea that subjects exerted cognitive effort while reading the T/F items. These results support a proposal made by

Johnson, Barnhardt, and Zhu (2005). Johnson and colleagues proposed that deception requires two processes, both of which require cognitive effort. Subjects must inhibit the truthful response and formulate a deceptive response. Johnson, Barnhardt, and Zhu (2004) showed that there are different patterns of brain activity for truthful and deceptive responding. Johnson, Barnhardt, and Zhu (2003, 2004) also have demonstrated that there are different patterns of brain activity for short- and long-term deceptive responding.

Research on PD and deception generally has found PD to be an indicator of deception. Heilveil (1976) found PD to be largest when subjects reported that they were deceptive when answering questions about themselves. Dionisio, Granholm, Hillix, and Perrine (2001) measured PD while participants made truthful and deceptive responses regarding semantic and episodic information. The largest increase in PD was found when subjects were deceptive, but there was no difference in PD for semantic and episodic information. Bradley and Janisse (1979) and Janisse and Bradley (1980) measured PD as subjects answered truthfully or deceptively to questions regarding a numbered card they had chosen. PD discriminated between the truthful and deceptive groups. Bradley and Janisse (1981) conducted a mock-crime experiment in which guilty subjects stole a dollar and hid it on their person. Innocent subjects did not steal anything. Subjects were given two polygraph tests: a concealed information test and a comparison question test. PD discriminated between the guilty and innocent subjects for the concealed information test but not for the comparison question test. In contrast to Bradley and Janisse (1981), Webb, Honts, Kircher, Bernhardt, and Cook (2008) administered a comparison question test and found that PD discriminated between guilty and innocent subjects as well as skin conductance and better than cardiovascular and respiration measures. Lubow and Fein

(1996) also conducted a mock-crime experiment and monitored PD while subjects completed a concealed information test. Stimuli in the concealed information test were pictures rather than the auditory questions used by Bradley and Janisse. As with previous work, PD discriminated between the guilty and innocent subjects.

Eye Blinks

Although Cook et al. (2008) did not examine the number of eye blinks made by subjects while they answered the T/F items, this variable was of interest in the present study. Previous research has demonstrated that eye blinks are related to cognitive processing (Siegle, Ichikawa, & Steinhauer, 2008; Stern, Walrath, & Goldstein, 1984). Results from Cook et al. showed that subjects inhibited their reading behavior when responding deceptively. Consequently, subjects may have blinked less often when they responded deceptively. In addition, there could be an increase in the number of blinks on the item that follows an item answered deceptively as the subject attempts to recover from the threat posed by the prior item. Recent work by Siegle et al. showed that eye blinks occur after information processing. Baker, Stern, and Goldstein (1992) did not find eye blinks to be diagnostic of deception, but Fukuda (2001) found that blinks discriminated between relevant and irrelevant items in a concealed information test. Eye blinks have promise as another measure of deception.

Motivation

Motivation is a factor that could affect how people respond when they answer items in a screening situation or criminal investigation. Previous work has shown that motivated subjects are more easily detected than subjects who are not as highly

motivated. Gustafson and Orne (1963) motivated half of their subjects to deceive the experimenter by telling them that only smart people who can control their emotions are able to hide information from the experimenter, and they would receive an extra dollar if they could do so. The other subjects did not receive these motivation instructions. Subjects who received the motivation instructions showed larger skin resistance responses when they hid information about a card they had selected and were more easily detected than were subjects who did not receive the motivation instructions.

DePaulo, Lanier, and Davis (1983) had subjects answer questions in front of a panel of their peers. Some questions were answered truthfully and some were answered deceptively. There were two motivation conditions. Subjects in the high motivation condition were told that lying successfully is important and that there is a link between a person's skill at lying and career success. Subjects in the low motivation condition were told that lying is like a game and the study was a game. DePaulo et al. then had judges rate the recordings made as subjects answered the questions in front of the panel. The judges rated the recordings on deceptiveness, planning, and tension. There were four conditions in which judges made their ratings. Results showed that the lies of the highly motivated subjects were detected more often than those of the low motivated subjects in three of four conditions.

A meta-analysis conducted by Kircher, Horowitz, and Raskin (1988) revealed that polygraph decision accuracies were higher in laboratory mock crime experiments when a monetary incentive to appear truthful was offered to subjects. A subsequent meta-analysis by DePaulo et al. (2003) revealed that deception cues were stronger in studies that offered a motivation to be successful at lying.

Others have found that motivation has no effect on detection of deception. Honts and Carlton (1990) offered half of their subjects an afternoon away from work if they were found truthful on a polygraph test that pertained to the theft of a gun. Other subjects were not offered an incentive to pass the polygraph test. Motivation had no effect on decision accuracy.

Taken together, these results suggest motivation may affect deception detection. Motivation was manipulated in the present study by offering subjects a monetary bonus to convince the examiner of their innocence. Subjects in the high motivation condition were offered a \$30 bonus beyond their base pay to produce a truthful outcome on the deception test. Subjects in the low motivation condition were offered a \$1 bonus.

Item and Task Difficulty

Hiding guilt is difficult and requires cognitive effort and self-control. The truth must be suppressed, the lie must be created, and the correct response must be given. The present study introduced another layer of difficulty by manipulating item difficulty. Subjects in the Cook et al. (2008) study answered both difficult and easy items. In the present study, half of the subjects answered both difficult and easy items, and the remaining subjects answered only easy items. Difficult items included a relative clause (e.g., I am innocent of taking the item *that was in the purse.*). Research has demonstrated that sentences with relative clauses are syntactically complex (Ferreira & Henderson, 1991) and that it becomes more difficult to integrate information in a sentence as the number of phrases and clauses in the sentence increases (Ferreira & Henderson, 1993). It should be more difficult for guilty subjects who answer both difficult and easy items to hide their guilt than for guilty subjects who answer only easy items. Both groups have to

exert mental effort to ensure that they not give themselves away, but guilty subjects who answer both difficult and easy items should have to expend more effort to correctly answer the items than subjects who answer only easy items.

After subjects completed the T/F items, they were asked to complete a Stroop task. In the Stroop task, color words and neutral stimuli were presented in different colors and the subject's task was to name the color of the ink in which the word was printed. Subjects had to exert cognitive effort to inhibit reading the word, which can interfere with naming the color of ink.

The Stroop task was included to test a prediction of the regulatory depletion hypothesis (Baumeister, Bratlavsky, Muraven, & Tice, 1998; Muraven, Shmueli, & Burkley, 2006; Muraven, Tice, & Baumeister, 1998). According to this hypothesis, self-control is a capacity-limited resource. If subjects engage in a task that requires self-control, they deplete the available resource, and performance on a subsequent task that also requires self-regulation will suffer. The Stroop task was chosen because prior research has shown that it requires self-regulation and performance suffers when subjects are depleted (Gailliot, Schmeichel, & Baumeister, 2006; Muraven et al., 2006). If guilty subjects expend more of this resource during the T/F task than innocent subjects, then they should perform less well on the Stroop task because it too requires self-regulation. Likewise, motivated subjects and subjects who answer both difficult and easy items should experience the effects of regulatory depletion on the Stroop task.

Trait Self-Control and Achievement Motivation

Other factors that might affect how a person answers items in a criminal investigation or screening situation are self-control ability and achievement motivation.

High self-control is associated with fewer problems with impulse control, better psychological and interpersonal adjustment, higher self-esteem, and higher grade point averages (Tangney, Baumeister, & Boone, 2004). High self-control also is associated with fewer thoughts about death (Gailliot et al., 2006). Self-control also may be related to a person's success at deception. Guilty subjects high in self-control ability may be better able to appear truthful to items by modulating their behavior and answering quickly and accurately than guilty subjects who are low in self-control ability.

Capa, Audiffren, and Ragot (2008) reported that subjects with high achievement motivation exerted more mental effort and performed better on a response time task than subjects low in achievement motivation. Cassidy (2002) found that subjects high in achievement motivation were more likely to escape an airplane via an emergency exit in a simulated air crash. Achievement motivation also may affect a person's ability to appear truthful to items in a criminal investigation or screening situation. Subjects high in achievement motivation may exert more cognitive effort and answer more quickly and accurately than subjects low in achievement motivation.

Summary

To summarize, the present study was designed to replicate and extend the results of Cook et al. (2008) and to determine if there are limits to the generalizability of their findings. Guilt, motivation, and item difficulty were manipulated to determine if the differences between guilty and innocent subjects are greatest when subjects are more motivated to appear truthful on the test and the task is difficult.

Objectives

Objectives 1 and 2 were of primary interest in the present research. Objectives 3 and 4 were exploratory in nature and attempted to determine additional factors that may affect detection rates or that can be used as indicators of deception.

Objective 1: Effects of Guilt, Motivation, and Item Difficulty on T/F Items

All of the subjects in Cook et al. (2008) received a combination of difficult and easy items and all were motivated by the promise of a \$30 reward to appear truthful on the test. The present research attempted to determine if the findings obtained under those experimental conditions can be replicated. As compared to innocent subjects, guilty subjects should take longer to complete the T/F items and should show large changes in PD on items answered deceptively. To be consistent with Cook et al., guilty subjects also should make more fixations and do more reading and rereading of crime-related items answered truthfully than crime-related items answered deceptively.

The present research also attempted to determine if there are effects of motivation and item difficulty on oculomotor and behavioral measures of deception. In addition to the high motivation condition and mixture of difficult and easy items used by Cook et al. (2008), the present experiment included a low motivation condition and a condition with only easy items.

The present research also attempted to determine if blink rate is affected by guilt, motivation, or item difficulty. This variable was not used by Cook et al. (2008), but it was included in the present study because prior research has shown it to be related to cognitive effort and deception. It was predicted that blink rate would decrease on items answered deceptively and increase on the item following an item answered deceptively.

Objective 2: Classification of Guilty and Innocent Subjects

The second objective of the present study was to assess the validity and reliability of oculomotor and behavioral measures for detecting deception and to develop a discriminant function to assess the accuracy of classifications based on a subset of those variables.

Objective 3: Effects of Self-Control and Achievement Motivation

Self-report measures of self-control and achievement motivation were collected and analyzed to determine if they moderate the relationship between guilt, PD, and RT. Subjects high in self-control and achievement motivation may be better able to modulate their behavior and answer quickly and accurately than subjects low in self-control and achievement motivation.

Objective 4: Effects of Guilt, Motivation, and Item Difficulty on Stroop RT and Accuracy

A Stroop task was included in the present research to determine if guilt, motivation, or item difficulty affect RT or accuracy on a subsequent task not related to the crimes under investigation. Effects of self-control and achievement motivation on Stroop RT and accuracy also were examined. Theoretically, deception, high levels of motivation, and difficult items in the primary task should adversely affect performance on the subsequent Stroop task. Individual differences in self-control and achievement motivation also should correlate with performance on the Stroop task. Subjects high in self-control and achievement motivation should be able to effectively modulate their behavior and answer more quickly and accurately on the Stroop task than subjects low in self-control and achievement motivation.

CHAPTER 2

METHOD

Subjects

One hundred thirty-six subjects were recruited from the general University of Utah population. Recruitment flyers were posted on campus that advertised an opportunity to earn \$30 and a possible bonus for participation in a psychological experiment. The flyer stated that potential participants must be student or staff and not need corrective lenses for reading. Of these 136 subjects, 8 chose not to participate after learning of their experimental condition, 5 did not follow instructions, 9 had poor or incomplete data, and 2 were lost due to experimenter error. This resulted in a sample size of 112 subjects. Demographic information obtained from subjects is presented in Tables 1 and 2.

Table 1

Means, Standard Deviations, and Ranges for Age, GPA, Self-control, Achievement Motivation and Marlowe-Crowne

Variable	<i>M</i>	<i>SD</i>	Range
Age	25.90	7.18	18 - 67
GPA	3.38	.44	2.09 - 4.00
Self-Control	119.57	17.66	75 - 163
Achievement Motivation	64.13	11.71	28 - 91
Marlowe-Crowne	15.50	5.22	1 - 28

Table 2
Frequencies and Percentages for Categorical Demographic Questions

Variable	Category	Frequency (%)
Marital Status	Single	81 (72.3)
	Married	23 (20.5)
	Divorced	7 (6.3)
	Separated	1 (.9)
Ethnicity	African-American	1 (0.9)
	Asian	11 (9.8)
	South Pacific Islander	1 (0.9)
	Latino/a	5 (4.5)
	Caucasian	89 (79.5)
	Other	5 (4.5)
Status	Student	96 (85.7)
	Staff	9 (8.0)
	Both	3 (2.7)
	Other	4 (3.6)
Class Standing	Freshman	6 (5.4)
	Sophomore	14 (12.5)
	Junior	24 (21.4)
	Senior	33 (29.5)
	Graduate	20 (17.9)
Enrollment Status	Full-time	78 (69.6)
	Part-time	16 (14.3)
	Other	4 (3.6)
Primary Language English	Yes	101 (90.2)
	No	11 (9.8)
Vision Correction	Glasses	15 (13.4)
	Contacts	10 (8.9)
	Neither	87 (77.7)

Design

The design was a 2 x 2 x 2 x 2 x (3 x 5) mixed design. The between-subjects variables were guilt (guilty and innocent), motivation (\$30 and \$1), item difficulty (mixed with both easy and difficult items and easy items only), and sex (male and female). The two within-subject factors were question type (neutral, cash, and exam) and repetition (5 repetitions of the T/F items). Time also was included as a within-subjects variable for the PD analyses. There were 40 levels for the time variable (10 Hz samples x 4 seconds). There were 7 subjects in each of the 16 cells of the between-groups portion of the design for a total of 112 subjects.

Apparatus

An Arrington ViewPoint Eye Tracker (Arrington Research, Inc, Scottsdale, AZ) was used to record eye movements and pupil diameter. The eye tracker was affixed to a pair of lensless plastic glasses. Viewing was binocular, but eye movement and pupil diameter were recorded only from the right eye. Data were collected at 30 Hz.

Eyelab 3.0 (Kircher & Webb, 2008) was used to present stimuli to the subject, and collect, edit, and analyze the oculomotor data. Eyelab communicated with the Arrington ViewPoint Eye Tracker software via functions in Arrington's software development kit (SDK). Both Eyelab and Viewpoint programs ran concurrently on a Hewlett-Packard 1.8 GHz computer.

The 30 Hz PD data were imported into CPSLAB 10 (Scientific Assessment Technologies, Inc, Salt Lake City, UT), a general-purpose computer program for psychophysiological research. Artifacts in the PD recordings caused by eyeblinks

automatically were tallied and edited from the recordings while the data were imported into CPSLAB.

Stimuli were presented to the subject on a 19-inch NEC MultiSync FE950+ flat screen CRT monitor. The monitor was positioned approximately 20 inches from the subject's eyes.

Stroop stimuli were presented to the subject using E-Prime 1.2 (Psychology Software Tools, Pittsburgh, PA). A Sony ECM-R100 microphone was used to record subjects' vocal responses.

Materials

T/F items

Subjects answered 48 test items, and the 48 test items were repeated five times in different orders. All subjects received the same random order. Sixteen items pertained to the theft of the \$20, 16 pertained to the theft of the exam, and 16 were neutral items. The items were arranged such that no two items from the same category appeared in succession. Half of the subjects received a mixed set of items that contained both easy and difficult items, and half received only easy items. The correct (nonincriminating) answer was True for 8 of the 16 items in each category and False for the remaining 8 items in each category. The valence of the item (worded positively: "I did take the \$20," or negatively: "I did not take the \$20") also was balanced for subjects in the mixed difficulty condition. Difficult items included a relative clause. Appearances of key words in the cash and exam items in both the easy and mixed conditions also were controlled. The key words in the cash items were *twenty dollars*, *wallet*, *purse*, and *secretary*. The key words in the exam items were *professor*, *disk*, *exam*, and *computer*.

Only one key word appeared in each item, and each key word appeared twice within the set of 8 true and 8 false items in both the easy and mixed conditions. Additionally, each key word appeared only once in the True/Positive, True/Negative, False/Positive, and False/Negative conditions in the mixed set of items for both cash and exam items. The test items are presented in Appendix A.

Stroop Items

Ninety-six Stroop (Stroop, 1935) trials were presented to subjects following completion of the T/F items. Congruent, incongruent, and neutral trials were presented. There were 72 congruent trials in which the words *RED*, *BLUE*, and *GREEN* were presented in the corresponding ink color (e.g., *RED* in red ink). There were 12 incongruent trials in which the words *RED*, *BLUE*, and *GREEN* were presented in a non-corresponding ink color (e.g., *RED* in blue ink). There were 12 neutral trials in which *JKM*, *XTQZ*, and *FPSCW* were presented in red, blue, and green ink. These neutral stimuli were used by Kane and Engle (2003) because they match the color words in length but do not include any of the letters from the color words. A review by Macleod (1991) concluded that interference increases if the stimulus is semantically similar to a color word. Nonwords were chosen as neutral stimuli to reduce interference. The stimuli were presented in random order and were counterbalanced such that each ink color appeared an equal number of times.

Questionnaires

Subjects completed several questionnaires, one of which was a demographic questionnaire (Appendix B).

Subjects also completed the Self-Control Scale (Tangney et al., 2004). The Self-Control Scale consists of 36 items and is designed to assess individual differences in self-control. Tangney et al. administered the questionnaire to 351 students in one study and to 255 students in another study. Internal consistency reliability estimates for both studies were .89. A 3-week test-retest reliability estimate was .89. Tangney et al. correlated scores on the Self-Control Scale with several other measures that included grade point average, an eating disorder inventory, alcohol abuse, psychological adjustment, self-esteem, and interpersonal adjustment. People with high self-control had higher grade point averages, fewer problems with impulse control as indexed by eating behaviors and alcohol abuse, better psychological adjustment and higher self-esteem, and better interpersonal adjustment than people with low self-control. The Self-Control Scale has adequate reliability. The validity evidence provided by the authors suggests the scale has some validity; however, more evidence is needed before the scale can be said to have adequate validity. This questionnaire is presented in Appendix C. Responses that are reverse scored are so indicated.

Because motivation was a key part of this experiment, subjects completed Cassidy and Lynn's (1989) achievement motivation questionnaire. The questionnaire was used to assess their motivations to determine if subjects are motivated by money, or if they complete tasks for their intrinsic value. The Cassidy-Lynn Achievement Motivation Questionnaire contains 49 items that load on the seven factors that define achievement motivation. Work Ethic addresses the need to achieve based on performance. Pursuit of Excellence addresses motivation to perform the best that one can. Status Aspiration is the desire to move up the social hierarchy and be a leader. Competitiveness addresses the

motivation to compete with others to win or succeed. Acquisitiveness for Money and Material Wealth addresses motivation for material or monetary reward. Mastery addresses motivation for problem-solving and succeeding when the process was difficult. Dominance addresses motivation to be in a dominant position or be a leader.

Cassidy and Lynn (1989) administered their instrument to 450 subjects. Factor analysis indicated the presence of the seven factors described previously. Cronbach's alpha ranged from .55 to .77 across the seven factors. Means and standard deviations were similar to those obtained from two other studies. The scale seems to have adequate reliability. Several correlations between the subscales and other achievement motivation subscales were significant, suggesting the scale has some validity. Intercorrelations were between .02 and .93. The largest correlations were between subscales that measured the same construct. The questionnaire is presented in Appendix D.

Some of the items on the achievement motivation questionnaire are items that some people may respond to in a socially desirable manner. Also, Tangney et al. (2004) found moderate correlations between the Self-Control Scale and social desirability. To assess a subject's tendency to respond in a socially desirable manner, the Marlowe-Crowne Social Desirability Questionnaire (Crowne & Marlowe, 1960) also was administered. The Marlowe-Crowne Social Desirability Scale is a 33-item scale with 18 items keyed true and 15 items keyed false to eliminate the possibility of a response set. Items are scored such that high scores indicate a person responded in a socially desirable manner. Crowne and Marlowe demonstrated internal consistency reliability of .88 and one-month test-retest reliability of .89 (Crowne & Marlowe, 1964). They correlated their scale with another social desirability scale and several scales of the Minnesota

Multiphasic Personality Inventory (MMPI) and found that correlations between their scale and the MMPI were similar to those for the other social desirability scale and MMPI subscales (Crowne & Marlowe, 1960, 1964). The Marlowe-Crowne appears to have adequate reliability and validity. The questionnaire is presented in Appendix E. The responses keyed true and the responses keyed false are so indicated.

Procedure

Interested subjects called a secretary to set up an appointment. The secretary ensured subjects were 18 years of age or older, university students or staff, and proficient at speaking and reading English. Subjects were emailed preliminary instructions and a map of campus two or three days prior to their scheduled appointment. Subjects were called the day before their appointment to remind them of their appointment and to ask them to get adequate sleep the night before and to refrain from caffeine for a few hours prior to their appointment. Prior experience suggested caffeine makes it more difficult to calibrate the subject because the pupils are more constricted.

Subjects arrived alone at their appointment. Instructions in an envelope taped to the door instructed them to enter the room, read and sign the consent form, fill out the questionnaires in order, and take the consent form and questionnaires with them when they left, and to give the materials to the experimenter. The instructions also stated they would receive further instructions after completing the questionnaires. After reading and signing the consent form, subjects completed the demographic questionnaire, the Cassidy-Lynn Achievement Motivation Questionnaire, the Self-Control Scale, and the Marlowe-Crowne Social Desirability Scale. Another envelope attached to the back of the questionnaire packet instructed them to locate a cassette tape, listen to the cassette, and

rewind and return the cassette to the location in which they found it. A hard copy of the cassette instructions was included in the envelope. A phone number was provided for subjects to call if they did not wish to participate.

Half of the subjects were in the guilty condition. Guilty subjects were instructed to go to a secretary's office on another floor of the building and ask the secretary where Dr. Laird's office was located. The secretary told the subject that there was no Dr. Laird in the building, and the subject thanked the secretary and left. The subject waited for the secretary to leave her office, then entered her office, found her purse, and removed \$20 from a wallet in the purse and concealed the money. Subjects were told to prepare an alibi in case they were caught and not leave fingerprints. Subjects were told that they had no more than 20 min to commit the crime and report to the experimenter.

Half of the subjects were in the innocent condition and did not steal anything. They were told that some subjects had to steal money from a secretary but that they were innocent subjects and did not have to steal anything. Innocent subjects were told to wait approximately 20 minutes before reporting to the experimenter. All subjects were told that there was another crime in which some subjects had to download an exam from a professor's computer onto a disk, but in actuality, no one committed that crime.

Half of the subjects were told that they would receive an additional \$30 bonus (high motivation condition) in addition to the possible \$30 advertised on the flyer if they were able to convince the examiner that they were innocent of both crimes. The remaining subjects were told that they would receive an additional \$1 bonus (low motivation condition) if they were able to convince the examiner of their innocence.

Subjects reported to the experimenter after committing their crime or after an appropriate waiting period. The experimenter placed the eye tracker on the subject and then calibrated the equipment. Instructions and practice items then were presented to the subject in a black font on a grey background. Subjects began answering test items after they had answered 15 practice items. Subjects received practice items only on the first repetition. Items were presented on the screen one at a time. A T/F appeared on the right side of the screen to remind subjects of their response options. Subjects responded to the test items using buttons on the computer keyboard. After responding, a TRUE or FALSE (depending on the subject's response) appeared on the right side of the screen for 500 ms to indicate the response to the subject. The next item appeared automatically. Subjects answered 48 items in this manner.

The subject then completed an intervening task. The intervening task consisted of 24 T/F general world knowledge questions. The purpose of the intervening task was to minimize retention of the test items and answers. Subjects completed 5 repetitions of the test items and 4 repetitions of the intervening task items. Intervening task items were not repeated across repetitions and were not used to make decisions about the subject's veracity. Subjects took between 3 and 6 minutes to complete the test items and between 2 and 4 minutes to complete the intervening task. Subjects were told to answer all items as quickly, consistently, and accurately as possible to avoid appearing deceptive. Dependent measures for the test items were response time (RT), proportion wrong, number of fixations, first pass duration, reread duration, and PD.

After the fifth repetition of the 48 T/F items, subjects completed a Stroop task (Stroop, 1935). Stimuli appeared in red, blue, or green ink on a white background, and

the subject responded vocally with the ink color. Subjects were told to answer as quickly and accurately as possible. Ninety-six trials were presented. Each trial began with READY? presented on the screen in black ink for 1000 ms, followed by a blank screen for 1000 ms, followed by a + in black ink for 500 ms, followed by a blank screen for 500 ms. The color word then was presented and remained on the screen until the subject responded. After the subject's response, another blank screen was presented for 1000 ms. Then the next trial began. The experimenter recorded subject responses for the duration of the approximately 7-minute task. The dependent measures for the Stroop task were RT and accuracy.

Following completion of the Stroop task, subjects were paid and debriefed. Subjects were told that their payment was based on their experimental condition. Guilty and innocent subjects in the low motivation condition were paid \$31 (\$30 base pay plus \$1 bonus). Guilty and innocent subjects in the high motivation condition were paid \$60 (\$30 base pay plus \$30 bonus). Subjects then were interviewed to assess any strategies they may have used and what they felt and thought while completing the tasks. The interview consisted of both multiple-choice and open-ended questions. The interview questions are presented in Appendix F. Subjects were paid and debriefed prior to the interview in an attempt to ensure more honesty from the subject than might have been obtained if the subject had not been paid and still was trying to convince the experimenter of their innocence. After the interview, subjects were asked not to discuss details of the study with others and released.

Dependent Measures

Areas of interest

An area of interest was defined for each T/F test item prior to the calculation of the dependent measures. The area of interest began with the first character of the item and ended after the period at the end of the item. First pass duration, second pass duration, number of fixations, and reread duration were computed for the fixations in each area of interest. RT, number of fixations, first pass duration, second pass duration, and reread duration were divided by the number of characters in an item to control for differing item lengths. Number of characters did not differ as a function of item difficulty, $p > .05$, but did differ as a function of question type, $p < .05$. Cash items were the longest ($M = 54.875$, $SD = 8.059$), followed by the exam ($M = 50.938$, $SD = 10.665$) and neutral items ($M = 45.906$, $SD = 9.410$).

Fixations

Fixations were determined from the data files produced by the Arrington by identifying a sequence of samples in which the eye showed little movement for 100 ms. The start of a fixation was determined if the samples within the 100 ms time window were within .5 standard deviations of each other. Three sequential samples greater than one standard deviation from the running average fixation position indicated the end of the fixation. The mean vertical position, mean horizontal position, and the duration of each fixation were calculated.

Response time

For the T/F items, RT was the time in s from the appearance of the item on the screen to a button press response from the subject. For the Stroop task, RT was the time in ms from the appearance of the word on the screen to a vocal response from the subject.

Proportion wrong

Proportion wrong for a particular item type (neutral, cash, exam) was computed by dividing the number of incorrect responses by the number of items (16).

Number of fixations

Number of fixations was the number of fixations in an area of interest.

First pass duration

First pass duration was the sum of all fixation durations in an area of interest before the eye fixated outside the area of interest.

Second pass duration

Second pass duration was the sum of all fixation durations in an area of interest after the first time the eye fixated outside the area of interest.

Reread duration

Reread duration was the sum of all leftward eye movement fixation durations in an area of interest. This measure was computed to assess rereading done by the subject whether or not the eye fixated outside the area of interest.

Pupil diameter

PD response curves were computed for each item. The response curve began when the item was presented and ended 4 s later. The original 30 Hz sampling rate was reduced to 10 Hz by calculating a mean for each successive set of three samples. This

procedure yielded 40 data points for each item (4 s at 10 Hz). The first data point was subtracted from every subsequent data point in the response curve to calculate deviations from initial level.

Two features were extracted from the PD response curve and are defined as follows:

Peak amplitude was computed by identifying high and low points in the response curve and computing the difference between each low point and every succeeding high point. Peak amplitude was the greatest difference. Response onset was defined as the low point from which peak amplitude was computed.

Area to full recovery was the area under the response curve from response onset to the point at which the response returned to the initial level or to the end of the 4-s sampling interval, whichever occurred first.

Item blink rate and Next item blink rate

Blink rate was the number of blinks per second. Blink rate was computed for each item (item blink rate) and for the item that followed (next item blink rate). A decrease in item blink rate may be thought of as an indicator of cognitive load, whereas an increase in next item blink rate may be viewed as a measure of relief.

CHAPTER 3

RESULTS

Significance for tests involving a repeated factor (repetition, question type, and time) used Huynh-Feldt corrections to degrees of freedom. Effects were significant at $p < .05$ unless otherwise noted. Analyses were conducted on both second pass and reread duration. Results were similar for the two and because second pass is a special case of reread duration, only results for reread duration are reported.

Manipulation Check

Analysis of variance was performed on the interview question subjects answered at the end of their session regarding the importance of the monetary bonus. Guilt, motivation, item difficulty, and sex were included as factors. The monetary bonus was more important to subjects promised a \$30 bonus for a truthful outcome ($M = 2.866$, $SE = .112$) than to subjects promised only \$1 for a truthful outcome ($M = 1.750$, $SE = .112$), $F(1, 96) = 49.61$, partial $\eta^2 = .341$. The bonus was more important to males ($M = 2.473$, $SE = .112$) than to females ($M = 2.143$, $SE = .112$), $F(1,96) = 4.35$, partial $\eta^2 = .043$. There also was a guilt by item difficulty interaction for importance of the monetary bonus, $F(1,96) = 11.05$, partial $\eta^2 = .103$. The monetary bonus was most important to guilty subjects who received mixed items and least important to innocent subjects who

received mixed items. Taken together, these results suggest the motivation manipulation affected perceptions of the importance of the monetary bonus.

The relationship between self-reports of the importance of the monetary bonus and scores on the Acquisitiveness for Money and Material Wealth subscale of the achievement motivation subscale also was examined. The correlation was not significant, $r = .161, p > .05$.

Objective 1: Effects of Guilt, Motivation, and Item Difficulty on T/F Items

Repeated measures analyses of variances (RMANOVAs) were conducted on each dependent variable. For RT, proportion wrong, number of fixations, first pass duration, reread duration, and blink rates, the between-subjects factors were guilt, motivation, item difficulty, and sex, and the within-subjects factors were question type and repetition. For PD, the between subjects factors were guilt, motivation, item difficulty, and sex, and the within-subjects factors were question type, repetition, and time. The RMANOVA analyses contained more than 60 sources of variance. To simplify presentation of the results and because guilt was the manipulation of greatest interest, only main effects of guilt and guilt interactions are presented and discussed in the text. Tables that include effect sizes for all statistically significant main effects and interactions for each dependent variable are presented in Appendix G. Four-way and higher order interactions are reported but not discussed.

Significant guilt by question type interactions were followed by contrasts to determine if there were differences between the crime and neutral items and between the cash and exam items within the guilty and innocent groups. Tests also were conducted to

determine if the guilty and innocent groups differed on responses to neutral, cash, and exam items. A p -value of .01 was used for follow-up tests.

There were 11 subjects who reported that English was not their native language. Three of these subjects were in the guilty group and eight were in the innocent group. There was no significant difference in the proportion of non-English speakers in the guilty and innocent groups, $p > .05$.

Means and standard deviations for the eight dependent variables are presented in Tables 3a and 3b for guilty and innocent subjects, respectively. They are broken down by motivation, item difficulty, and question type. There were few interpretable effects for sex, so means and standard deviations were pooled over levels of sex.

Table 3a

Means (and Standard Deviations) for the Dependent Variables by Motivation, Item Difficulty, and Question Type for Guilty Subjects

Dependent Variable	Low Motivation						High Motivation					
	Easy		Mixed		Easy		Mixed		Easy		Mixed	
	Neutral	Cash	Exam									
RT	.060 (.015)	.053 (.014)	.059 (.015)	.059 (.010)	.053 (.010)	.060 (.012)	.059 (.012)	.047 (.010)	.056 (.011)	.063 (.020)	.059 (.019)	.068 (.021)
Proportion Wrong	.102 (.077)	.039 (.034)	.038 (.034)	.047 (.036)	.057 (.035)	.054 (.030)	.110 (.111)	.063 (.051)	.063 (.049)	.071 (.048)	.046 (.039)	.050 (.045)
Number of Fixations	.183 (.042)	.160 (.037)	.175 (.040)	.190 (.029)	.170 (.028)	.190 (.031)	.176 (.028)	.144 (.028)	.169 (.027)	.187 (.049)	.178 (.044)	.204 (.057)
First Pass Duration	.049 (.012)	.042 (.009)	.047 (.010)	.050 (.009)	.044 (.009)	.049 (.009)	.049 (.010)	.040 (.010)	.047 (.009)	.048 (.013)	.047 (.014)	.051 (.014)
Reread Duration	.016 (.006)	.013 (.005)	.016 (.005)	.016 (.004)	.014 (.003)	.017 (.003)	.018 (.006)	.013 (.005)	.018 (.006)	.014 (.006)	.012 (.005)	.017 (.007)
Pupil Diameter	-.075 (.045)	.004 (.044)	-.019 (.044)	-.076 (.037)	.002 (.040)	-.025 (.039)	-.084 (.037)	.023 (.058)	-.012 (.035)	-.080 (.085)	.016 (.081)	-.026 (.051)
Item Blink Rate	.650 (.194)	.694 (.212)	.682 (.229)	.627 (.190)	.614 (.172)	.658 (.141)	.659 (.214)	.640 (.227)	.650 (.173)	.697 (.198)	.620 (.189)	.674 (.170)
Next Item Blink Rate	.696 (.213)	.649 (.214)	.668 (.209)	.641 (.163)	.657 (.169)	.591 (.173)	.638 (.183)	.658 (.220)	.636 (.200)	.639 (.169)	.693 (.172)	.652 (.195)

RT, First Pass Duration, and Reread Duration are seconds per character. Number of Fixations is number of fixations per character.

PD is change from baseline in millimeters. Item Blink Rate is number of blinks per second on each item, and Next Item Blink Rate is number of blinks per second on the item following neutral, cash, and exam items.

Table 3b

Means (and Standard Deviations) for the Dependent Variables by Motivation, Item Difficulty, and Question Type for Innocent Subjects

Dependent Variable	Low Motivation						High Motivation						
	Easy			Mixed			Easy			Mixed			
	Neutral	Cash	Exam	Neutral	Exam	Cash	Neutral	Exam	Cash	Neutral	Exam	Cash	Exam
RT	.056 (.017)	.057 (.019)	.059 (.022)	.052 (.009)	.057 (.016)	.053 (.015)	.046 (.007)	.044 (.006)	.042 (.005)	.050 (.013)	.044 (.006)	.052 (.016)	.054 (.017)
Proportion Wrong	.054 (.041)	.032 (.023)	.027 (.024)	.063 (.063)	.055 (.035)	.051 (.026)	.058 (.049)	.028 (.021)	.033 (.032)	.053 (.039)	.028 (.021)	.051 (.029)	.045 (.030)
Number of Fixations	.175 (.053)	.178 (.059)	.183 (.067)	.171 (.023)	.188 (.044)	.181 (.041)	.150 (.023)	.142 (.019)	.139 (.015)	.162 (.033)	.142 (.019)	.173 (.045)	.173 (.047)
First Pass Duration	.048 (.016)	.046 (.014)	.048 (.016)	.045 (.008)	.048 (.012)	.047 (.013)	.039 (.007)	.036 (.005)	.036 (.005)	.044 (.013)	.036 (.005)	.044 (.015)	.044 (.016)
Reread Duration	.015 (.007)	.015 (.007)	.016 (.008)	.012 (.003)	.015 (.006)	.013 (.005)	.012 (.004)	.011 (.003)	.010 (.003)	.012 (.005)	.011 (.003)	.014 (.006)	.014 (.006)
Pupil Diameter	-.060 (.037)	-.040 (.047)	-.033 (.051)	-.067 (.062)	-.026 (.037)	-.042 (.046)	-.066 (.061)	-.004 (.034)	-.011 (.036)	-.048 (.039)	-.004 (.034)	.005 (.034)	.010 (.030)
Item Blink Rate	.725 (.179)	.734 (.188)	.738 (.213)	.634 (.160)	.632 (.127)	.636 (.149)	.792 (.257)	.793 (.199)	.794 (.187)	.716 (.226)	.793 (.199)	.701 (.194)	.690 (.240)
Next Item Blink Rate	.731 (.205)	.723 (.175)	.744 (.188)	.643 (.123)	.628 (.143)	.613 (.152)	.812 (.181)	.796 (.219)	.760 (.234)	.703 (.207)	.796 (.219)	.690 (.222)	.706 (.219)

RT, First Pass Duration, and Reread Duration are seconds per character. Number of Fixations is number of fixations per character.

PD is change from baseline in millimeters. Item Blink Rate is number of blinks per second on each item, and Next Item Blink Rate is number of blinks per second on the item following neutral, cash, and exam items.

Response Time

The main effect of guilt was significant, $F(1,96) = 5.28$. Guilty subjects took longer to respond ($M = .058$, $SE = .002$) than did innocent subjects ($M = .052$, $SE = .002$). The effect of guilt on RT was not moderated by motivation or item difficulty.

The guilt by question type interaction was significant, $F(2,192) = 15.89$, and is presented in Figure 1. For guilty subjects, RTs were longest for the exam items ($M = .061$, $SE = .002$), followed by the neutral items ($M = .060$, $SE = .002$), and the cash items ($M = .053$, $SE = .002$). For innocent subjects, RTs were nearly identical for the neutral and cash ($M_s = .051$, $SE_s = .002$) items, and both were shorter than RTs to the exam items ($M = .053$, $SE = .002$). Follow-up tests indicated that guilty subjects responded more quickly to the crime-related items than to the neutral items, $F(1,55) = 17.28$, partial $\eta^2 = .239$, and responded more quickly to the cash items than to the exam items, $F(1,55) = 117.79$, partial $\eta^2 = .682$. Innocent subjects also responded more quickly to the cash items than to the exam items, $F(1,55) = 27.96$, partial $\eta^2 = .337$. Follow-up tests also indicated that guilty and innocent subjects differed in RT only on the neutral items, $p < .01$. The guilt by question type interaction was not moderated by motivation or item difficulty.

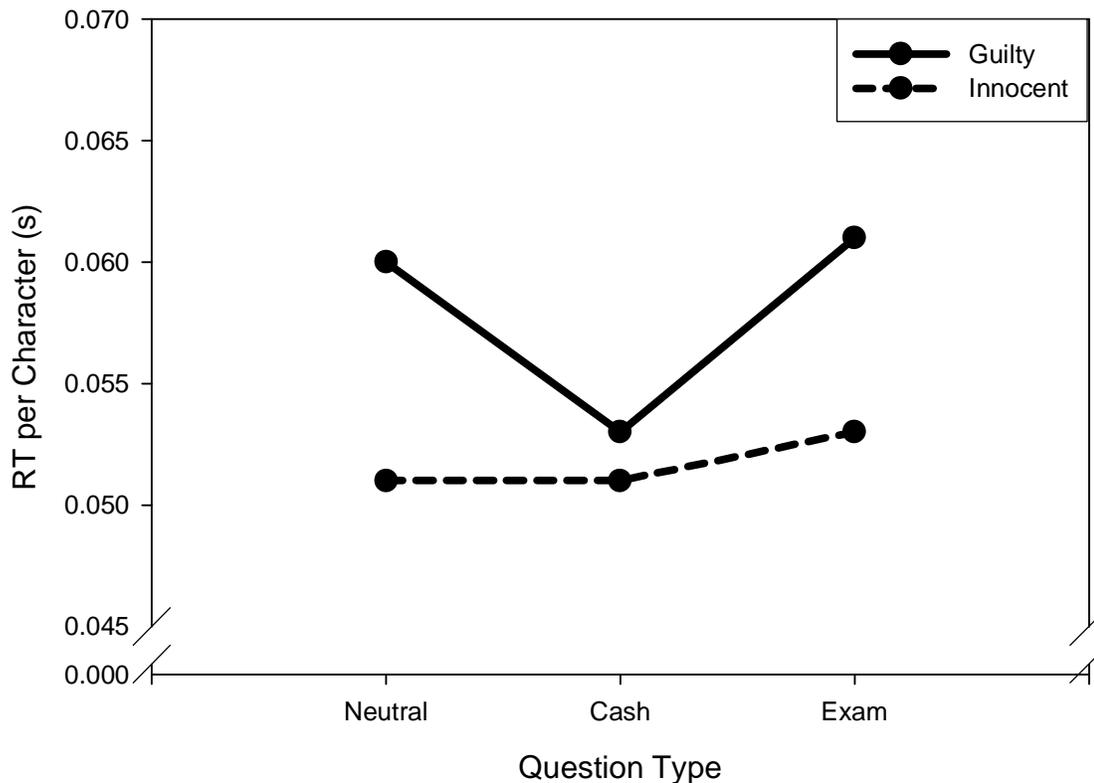


Figure 1. Guilt by question type interaction for RT.

Proportion Wrong

The main effect of guilt was significant, $F(1,96) = 5.63$. Guilty subjects tended to make more mistakes overall ($M = .062$, $SE = .005$) than did innocent subjects ($M = .046$, $SE = .005$).

The guilt by item difficulty interaction was significant, $F(1,96) = 4.62$, and is illustrated in Figure 2. Guilty subjects in the easy item condition answered the most items incorrectly ($M = .069$, $SE = .007$), followed by guilty subjects in the mixed condition ($M = .054$, $SE = .007$), innocent subjects in the mixed condition ($M = .053$, $SE = .007$), and innocent subjects in the easy condition ($M = .039$, $SE = .007$).

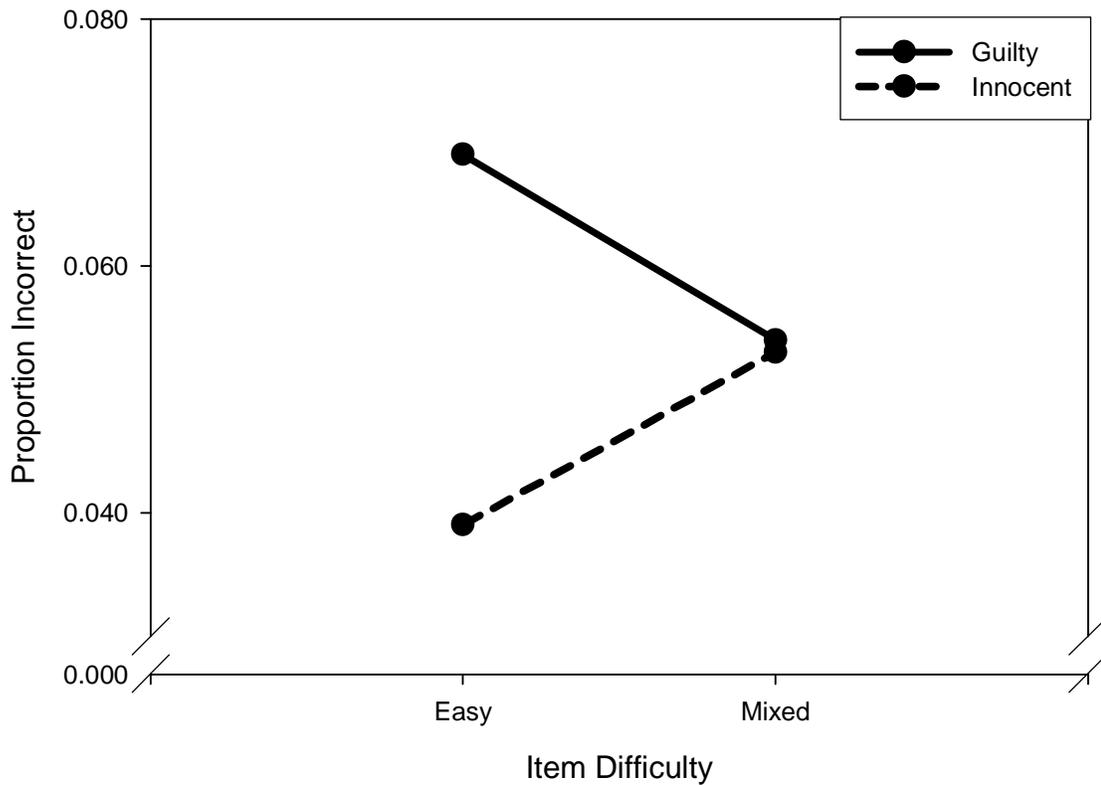


Figure 2. Guilt by item difficulty interaction for proportion wrong.

The guilt by motivation by sex by question type by repetition interaction was significant, $F(8,768) = 2.64$.

Number of Fixations

The guilt by question type interaction was significant, $F(2,192) = 20.03$, and is presented in Figure 3. Guilty subjects made similar numbers of fixations on the neutral and exam items and the fewest on the cash items. Follow-up tests indicated that guilty subjects made more fixations on neutral items than on crime-related items, $F(1,55) = 13.30$, partial $\eta^2 = .195$, and more fixations on exam items than on cash items, $F(1,55) =$

99.59, partial $\eta^2 = .644$. Follow-up tests also indicated that guilty and innocent subjects differed in number of fixations for the neutral items only, $p < .01$.

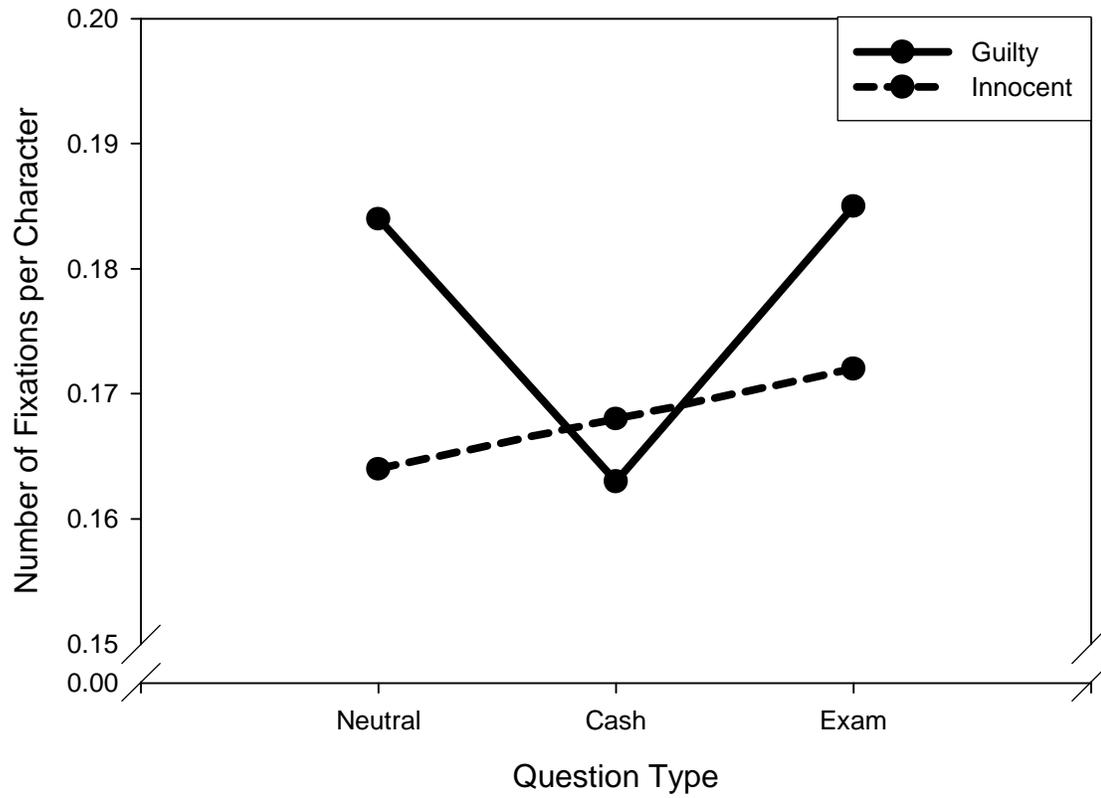


Figure 3. Guilt by question type interaction for number of fixations.

The guilt by motivation by question type interaction also was significant, $F(2,192) = 3.38$. This effect is presented graphically in Figures 4a and 4b. Guilty subjects made fewer fixations on the cash items than the neutral or exam items in both motivation conditions. Motivation had more effect on innocent subjects than guilty subjects. Innocent subjects in the low motivation condition made more fixations than did innocent subjects in the high motivation condition. Follow-up analyses indicated that the magnitude of the guilt by question type interaction was similar for both motivation groups (low: $F(2,108) = 11.21$, partial $\eta^2 = .172$; high: $F(2,108) = 11.11$, partial $\eta^2 = .171$).

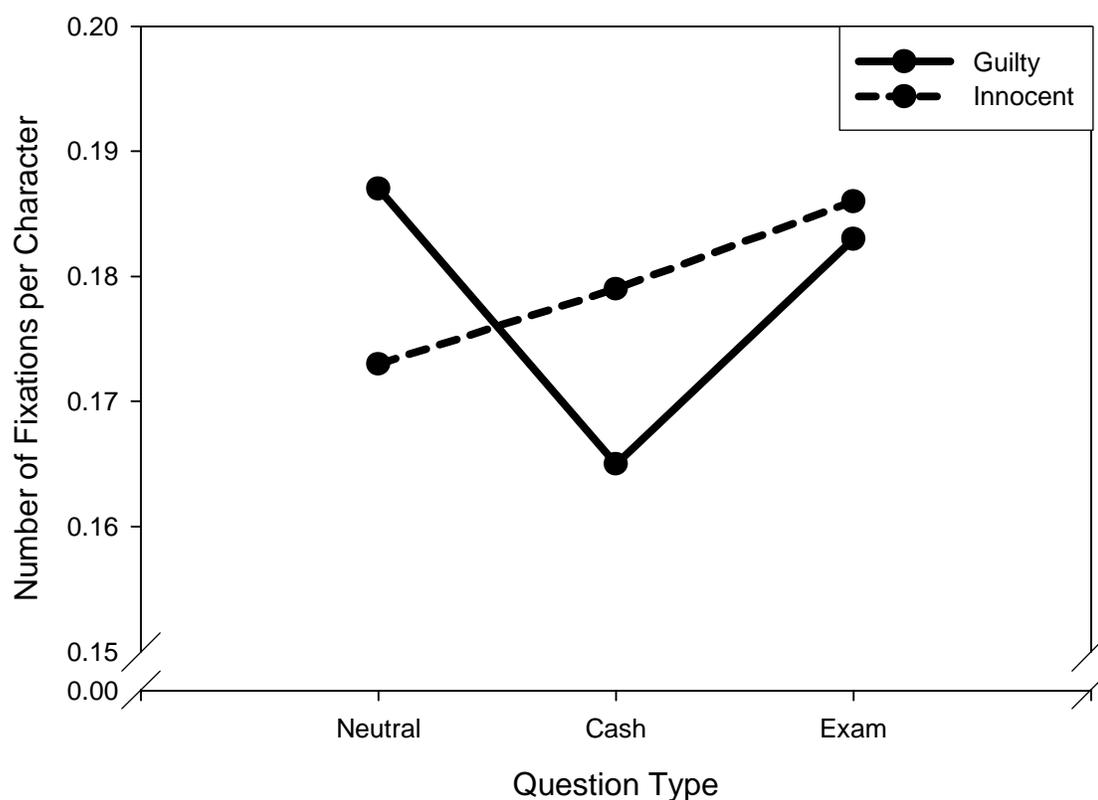


Figure 4a. Guilt by question type interaction for number of fixations for low motivation group.

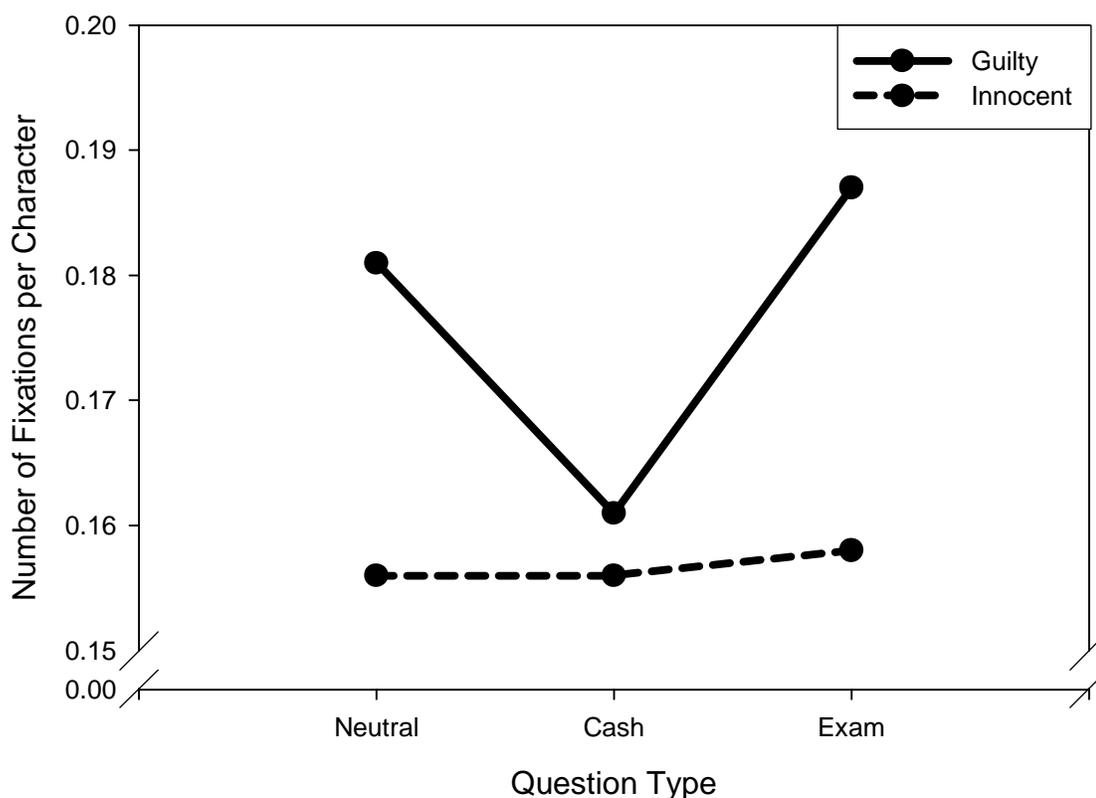


Figure 4b. Guilt by question type interaction for number of fixations for high motivation group.

First Pass Duration

The guilt by question type interaction was significant, $F(2,192) = 18.69$, and is presented in Figure 5. Guilty subjects spent more time reading the neutral and exam items than the cash items. Follow-up tests indicated that guilty subjects spent more time reading the neutral items than the crime-related items, $F(1,55) = 21.96$, partial $\eta^2 = .285$, and more time reading the exam than the cash items, $F(1,55) = 104.74$, partial $\eta^2 = .656$. There were no significant differences between guilty and innocent subjects in responses to the three item types, although the difference between guilty and innocent subjects in time spent reading the neutral items was marginally significant, $p = .02$.

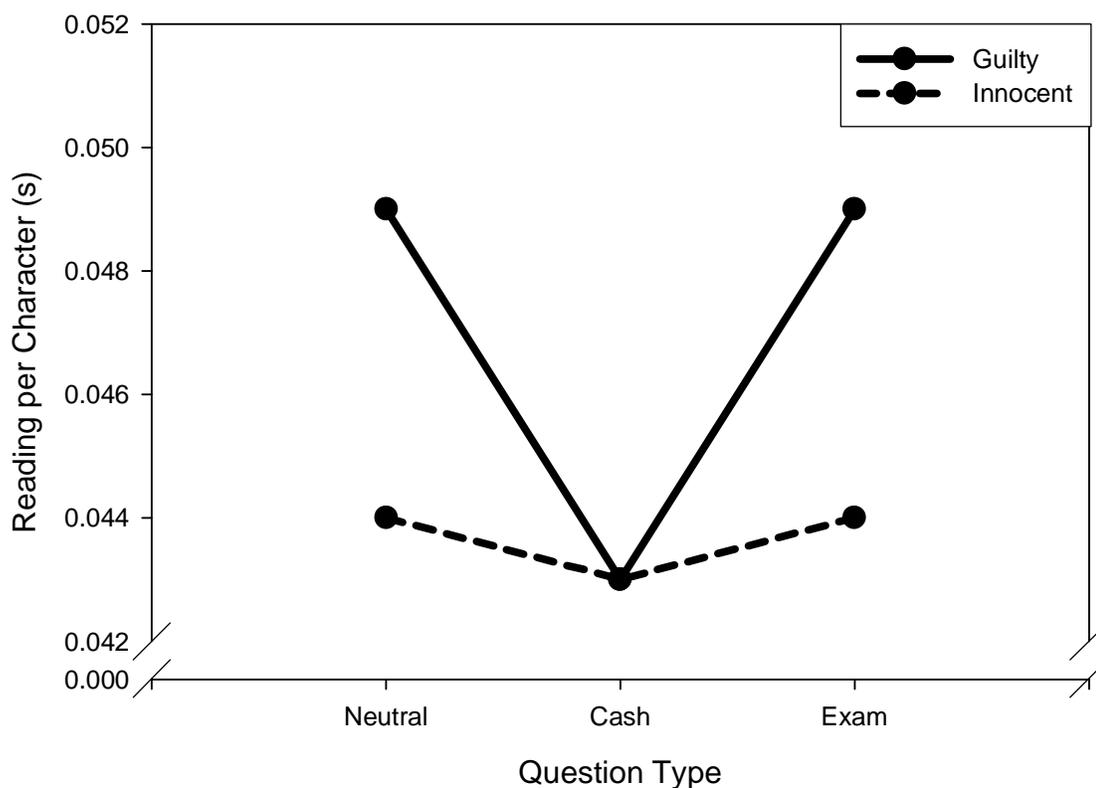


Figure 5. Guilt by question type interaction for first pass duration.

The four-way interaction between guilt, motivation, sex, and question type was significant, $F(2,192) = 4.18$, as was the five-way interaction between guilt, item difficulty, sex, question type, and repetition, $F(8,768) = 2.71$.

Reread Duration

The main effect of guilt was significant, $F(1,96) = 4.73$. Guilty subjects did more rereading ($M = .016$, $SE = .001$) than did innocent subjects ($M = .013$, $SE = .001$). The effect of guilt was not moderated by motivation or item difficulty.

The guilt by question type interaction was significant, $F(2,192) = 15.17$ and is presented in Figure 6. Both groups did the same amount of rereading on cash items and

did the most rereading on exam items. Follow-up tests indicated that guilty subjects did more rereading on exam items than cash items, $F(1,55) = 132.40$, partial $\eta^2 = .707$. The difference between neutral and crime-related items was marginally significant, $F(1,55) = 7.17$, $p = .01$, partial $\eta^2 = .115$. Guilty subjects did more rereading on neutral items than crime-related items. Innocent subjects did more rereading on exam items than cash items, $F(1,55) = 37.21$, partial $\eta^2 = .404$. Follow-up tests also indicated guilty and innocent subjects differed in rereading on neutral items, $p < .01$. The difference between guilty and innocent subjects on exam items was marginally significant, $p = .01$. The guilt by question type interaction was not moderated by motivation or item difficulty.

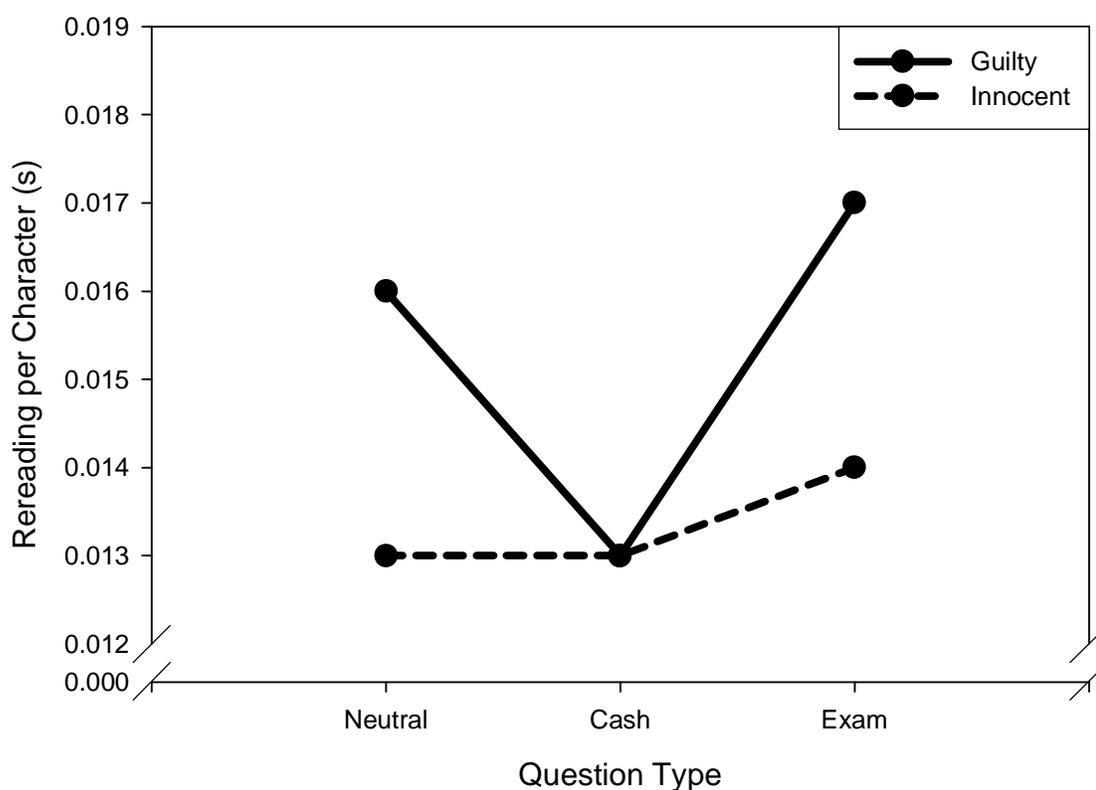


Figure 6. Guilt by question type interaction for reread duration.

The guilt by motivation by sex by repetition interaction was significant, $F(4,384) = 2.73$.

Pupil Diameter

PD was assessed by examining change from baseline. The first data point was subtracted from every subsequent data point in the response curve. A positive value indicated PD increased relative to baseline, and a negative value indicated PD decreased relative to baseline.

PD response curves for the guilt by question type by time interaction are presented in Figures 7a and 7b for guilty and innocent subjects, respectively.

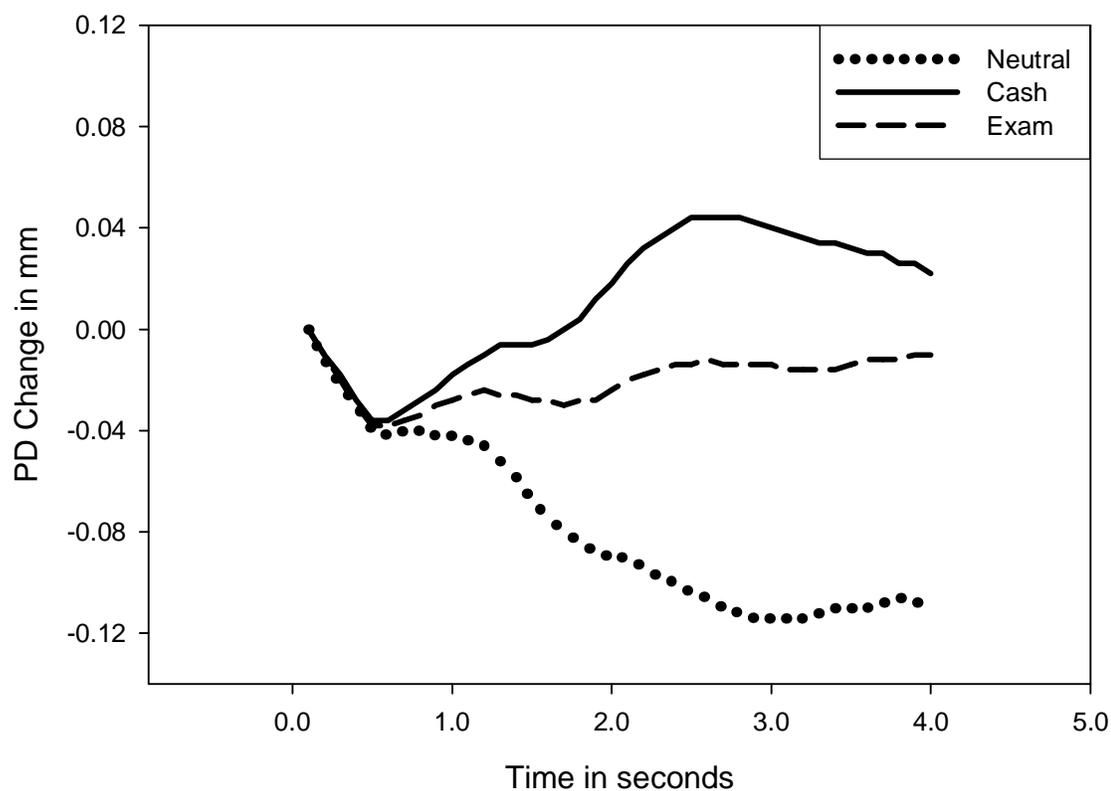


Figure 7a. Guilt by question type by time interaction for PD for guilty subjects.

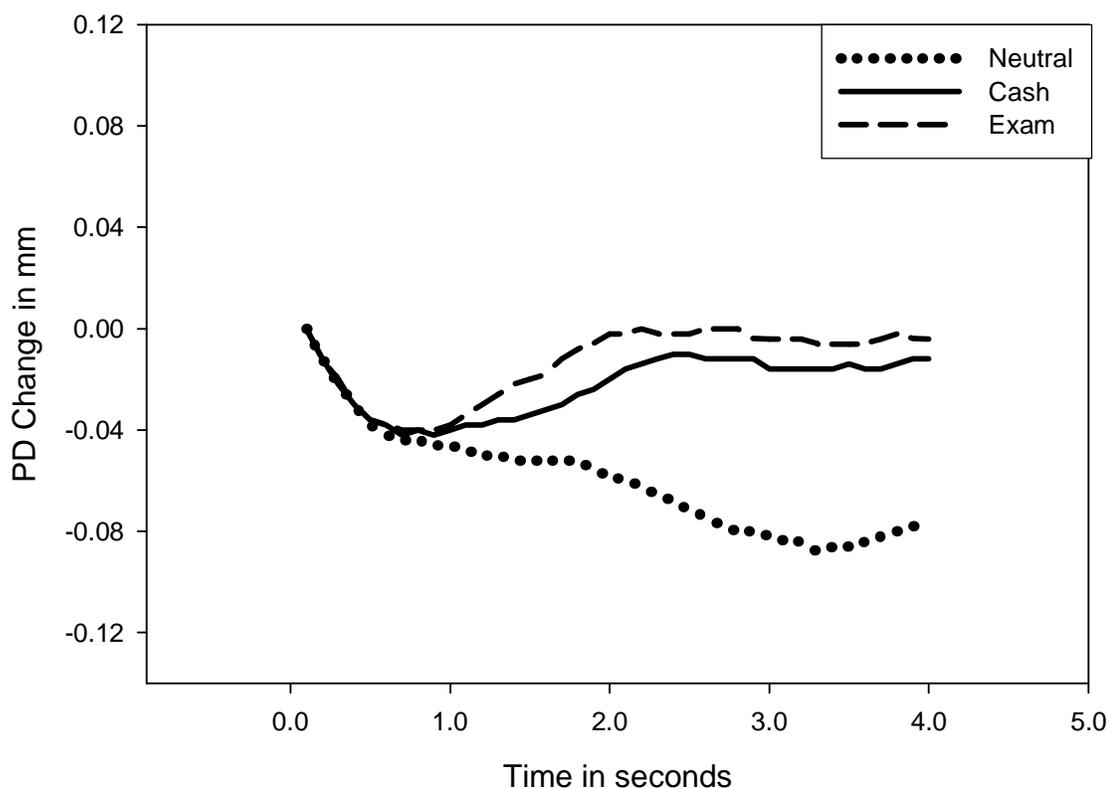


Figure 7b. Guilt by question type by time interaction for PD for innocent subjects.

The guilt by question type interaction was significant, $F(2,192) = 17.89$, as was the guilt by question type by time interaction, $F(78,7488) = 11.15$. After an initial 500 ms decrease in PD, guilty subjects showed a greater increase in PD in response to crime items than to neutral items, $F(1,55) = 109.05$, partial $\eta^2 = .665$, and in response to cash items than to exam items, $F(1,55) = 20.75$, partial $\eta^2 = .274$. Innocent subjects showed a greater increase in PD to crime-related than to neutral items, $F(1,55) = 58.46$, partial $\eta^2 = .515$, with a slightly larger PD to exam than to cash items, $F(1,55) = 10.02$, partial $\eta^2 = .154$. Follow-up tests indicated that guilty and innocent subjects differed in PD responses to the cash items only, $p < .01$.

The guilt by repetition interaction also was significant, $F(4,384) = 3.36$. The difference between guilty and innocent subjects varied significantly but not linearly across the five repetitions.

Two of the four-way interactions were statistically significant. The guilt by motivation by sex by time interaction was significant, $F(39,3744) = 4.23$, as was the guilt by question type by repetition by time interaction, $F(312,29952) = 2.05$.

PD responses to easy and difficult items within the mixed item difficulty condition also were examined. The main effect of difficulty was statistically significant, $F(1,48) = 40.83$, partial $\eta^2 = .460$. Subjects showed a greater change from baseline to the difficult items ($M = -.038$, $SE = .006$) than to the easy items ($M = -.021$, $SE = .005$).

Item Blink Rate

The guilt by motivation by repetition interaction was statistically significant, $F(4,384) = 2.71$. Follow-up analyses indicated the simple guilt by repetition interaction was marginally significant for the high motivation group, $F(4,216) = 3.69$, $p = .01$, partial $\eta^2 = .064$, and not significant for the low motivation group, $F(4,216) = .66$, $p = .56$. In the high motivation condition, blink rate generally increased across repetitions for innocent subjects and decreased for guilty subjects.

The guilt by question type by sex interaction was significant, $F(2,192) = 3.91$. Follow-up analyses indicated that the simple guilt by question type interaction was not significant for males or females at $p < .01$.

The four-way interaction between guilt, motivation, item difficulty, and sex was marginally significant, $F(1,96) = 3.79$, $p = .05$, partial $\eta^2 = .038$.

Next Item Blink Rate

The guilt by question type interaction was statistically significant, $F(2,192) = 4.44$, and is presented in Figure 8. Guilty subjects showed the greatest increase in blink rate on items that followed a cash item. Innocent subjects showed the greatest increase in blink rate on items that followed neutral and exam items. Follow-up analyses comparing crime-related and neutral items and cash and exam items within the guilty and innocent groups were not significant at $p < .01$, nor were there significant differences between the two groups for any of the three item types at $p < .01$.

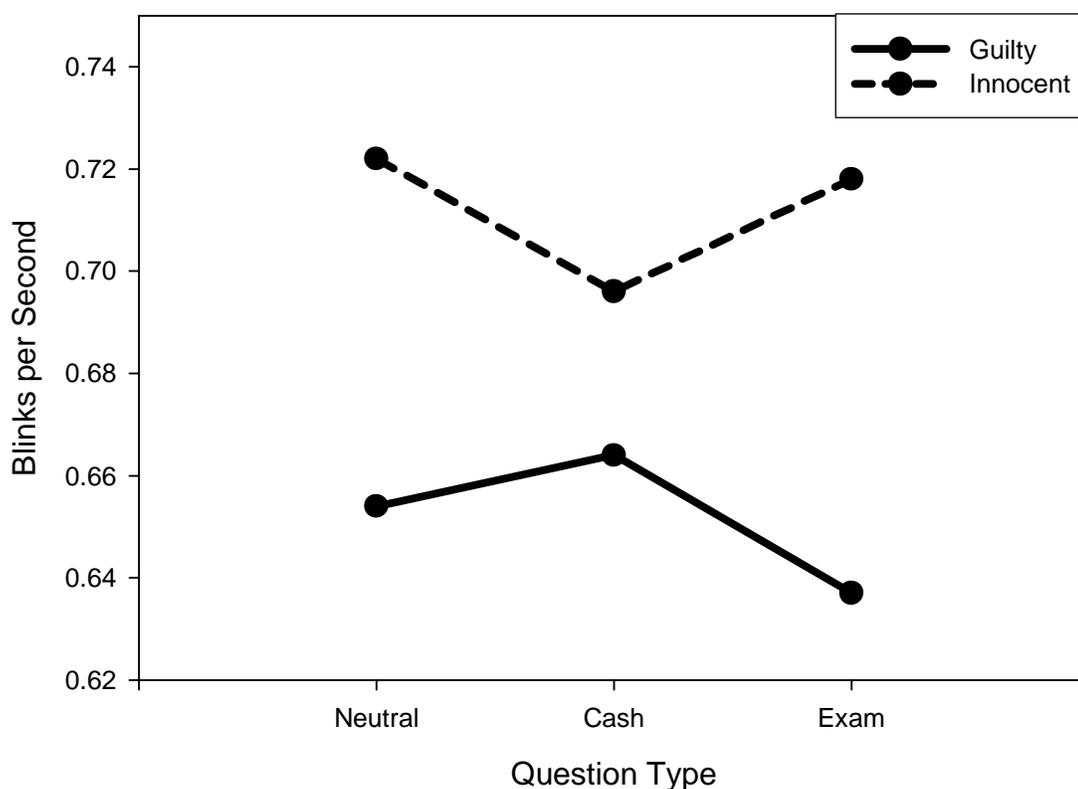


Figure 8. Guilt by question type interaction for next item blink rate.

The guilt by motivation by repetition interaction was significant, $F(4,384) = 2.72$. Follow-up analyses indicated the simple guilt by repetition interaction was significant for the high motivation group, $F(4,216) = 3.76$, partial $\eta^2 = .065$, but not the low motivation group, $F(4,216) = .53$, $p = .64$. In the high motivation condition, blink rate generally increased across repetitions for innocent subjects and decreased across repetitions for guilty subjects.

The four-way interaction between guilt, item difficulty, question type, and repetition also was statistically significant, $F(8,768) = 1.20$. The four-way interaction between guilt, motivation, item difficulty, and sex was marginally significant, $F(1,96) = 3.90$, $p = .051$, partial $\eta^2 = .039$.

Objective 2: Classification of Guilty and Innocent Subjects

New dependent variables were created to develop statistical classifiers. One dependent variable was the difference between the mean for crime-related items and the mean for neutral items. Another new dependent variable was created by computing the difference between the mean for cash items and the mean for exam items. The third new dependent variable was the mean for the neutral items. This procedure was used for all behavioral and oculomotor variables.

To assess the diagnostic validity of a derived outcome measure, it was correlated with a dichotomous variable that distinguished between guilty (coded 0) and innocent subjects (coded 1). To assess the reliability of the measure, responses were averaged within item types and within repetitions. This resulted in one mean for the neutral items, one mean for the cash items, and one mean for the exam items for each of the five repetitions. The difference between the crime items and the neutral items and the

difference between the cash items and the exam items was computed for each repetition. Coefficient alpha (Cronbach, 1951) then was computed to assess the internal consistency of the measures over repetitions.

The negative point-biserial correlations for RT, number of fixations, first pass duration, and reread duration for the neutral items indicate guilty subjects took longer to respond, made more fixations, and did more reading and rereading on neutral items as compared to innocent subjects. The correlations for the difference between the crime and neutral items and the difference between the cash and exam items for RT, number of fixations, first pass duration, and reread duration were generally positive. As compared to innocent subjects, guilty subjects took less time to respond, made fewer fixations, and did less reading and rereading on crime-related items than neutral items. Guilty subjects also took less time to respond, made fewer fixations, and did less reading and rereading of cash items than exam items. The point-biserial correlations and reliabilities for each measure are presented in Table 4 separately for the easy and mixed item difficulty conditions.

Table 4
Point-biserial Correlations (and Reliabilities) for Easy and Mixed
Item Difficulty Conditions

Outcome Measure	Easy Items	Mixed Items
RTNeutral	-.282* (.938)	-.356* (.958)
RTCrimeNeutral	.312* (.788)	.301* (.703)
RTCashExam	.529** (.434)	.431** (.360)
PropWrongNeutral	-.327* (.881)	-.014 (.768)
PropWrongCrimeNeutral	.242 (.741)	-.002 (.733)
PropWrongCashExam	.082 (.052)	.031 (.316)
NFixNeutral	-.217 (.933)	-.314* (.929)
NFixCrimeNeutral	.329* (.807)	.335* (.762)
NFixCashExam	.509** (.572)	.548** (.483)
FirstPassNeutral	-.224 (.935)	-.205 (.917)
FirstPassCrimeNeutral	.293* (.622)	.244 (.654)
FirstPassCashExam	.549** (.582)	.545** (.433)
RereadNeutral	-.286* (.922)	-.302* (.905)
RereadCrimeNeutral	.224 (.683)	.310* (.705)
RereadCashExam	.488** (.516)	.489** (.471)
PDAreaNeutral	.397** (.582)	.152 (.364)
PDAreaCrimeNeutral	-.396** (.759)	-.156 (.666)
PDAreaCashExam	-.409** (.640)	-.578** (.577)
PDAmplitudeNeutral	.299* (-.117)	.160 (-.210)
PDAmplitudeCrimeNeutral	-.297* (.686)	-.164 (.642)
PDAmplitudeCashExam	-.348** (.563)	-.537** (.523)
ItemBlinkRateNeutral	.244 (.909)	.033 (.862)
ItemBlinkRateCrimeNeutral	-.025 (.572)	.052 (.561)
ItemBlinkRateCashExam	-.014 (.247)	.258 (.535)
NextItemBlinkRateNeutral	.262 (.875)	.101 (.860)
NextItemBlinkRateCrimeNeutral	-.010 (.315)	-.142 (.325)
NextItemBlinkRateCashExam	-.169 (.104)	-.368** (.398)

* $p < .05$, ** $p < .01$

RT = response time per character, PropWrong = proportion wrong, NFix = number of fixations per character, FirstPass = time spent reading per character, Reread = time spent rereading per character, PDArea = pupil diameter area under the curve, PDAmplitude = pupil diameter peak amplitude. ItemBlinkRate = number of blinks per second on each item type. NextItemBlinkRate = number of blinks per second on the item following each item type. Neutral = response for neutral items, CrimeNeutral = difference between crime-related and neutral items, CashExam = difference between cash and exam items.

Eight variables then were selected for possible inclusion in the discriminant function: RTCrimeNeutral, RTCashExam, NFixCrimeNeutral, NFixCashExam, FirstPassCashExam, RereadCashExam, PDAreaCashExam, and NextItemBlinkRateCashExam. Seven of these variables were selected because they had point-biserial correlations of at least .30 in both the easy and mixed item difficulty groups. Although NextItemBlinkRateCashExam did not have a point-biserial correlation of at least .30 in both item difficulty groups, it was included because it was a variable of interest. PD area was selected to be consistent with Cook et al. (2008).

For each of the eight selected variables, the point-biserial correlation with guilt was computed for each repetition separately. Those correlations are presented in Table 5. The diagnostic validity appeared to vary across repetitions differently for the eight variables.

The intercorrelations among the eight variables are presented in Table 6. As expected, several potential predictor variables were highly intercorrelated.

The eight variables were submitted to a stepwise regression. Results indicated FirstPassCashExam, PDAreaCashExam, RTCrimeNeutral, and NextItemBlinkRateCashExam best predicted guilt. Coefficients for all four were statistically significant, $ps < .05$. These four variables were used to create linear and quadratic discriminant functions and classification rates. The homogeneity of variance-covariance matrices assumption required for linear discriminant function analysis was not met, so quadratic analysis also was performed. Classification accuracy was poorer for the quadratic function. Only the simpler, linear solution is reported. The standardized canonical discriminant function coefficients and the functions at group centroids are

presented in Tables 7 and 8, respectively. Classification results and jackknifed classification results for the linear function is presented in Table 9. Jackknifed classification results were obtained with the leave-one-out method where each case was classified with coefficients computed from all other cases.

Table 5

Point-biserial Correlations by Repetition for the Eight Variables Selected for Possible Inclusion in the Discriminant Function

Variable	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
RTCrimeNeutral	.189*	.237*	.260*	.140	.236*
RTCashExam	.119	.215*	.367**	.356**	.268**
NFixCrimeNeutral	.230*	.262**	.240*	.234*	.217*
NFixCashExam	.188*	.330**	.436**	.333**	.277**
FirstPassCashExam	.118	.383**	.532**	.376**	.218*
RereadCashExam	.238*	.343**	.386**	.244**	.179
PDAreaCashExam	-.485**	-.231*	-.323**	-.272**	-.210*
NextItemBlinkRateCashExam	-.183	-.221*	-.249**	-.088	.036

* $p < .05$, ** $p < .01$

RT = response time per character, NFix = number of fixations per character, FirstPass = time spent reading per character, Reread = time spent rereading per character, PDArea = pupil diameter area under the curve. NextItemBlinkRate = number of blinks per second on the item following each item type. Neutral = response for neutral items, CrimeNeutral = difference between crime-related and neutral items, CashExam = difference between cash and exam items.

Table 6

Intercorrelations Among RTCrimeNeutral, RTCashExam, NFixCrimeNeutral, NFixCashExam, FirstPassCashExam, RereadCashExam, PDCashExam, and NextItemBlinkRateCashExam

Variable	RT CrimeNeutral	RT CashExam	NFix CrimeNeutral	NFix CashExam	FirstPass CashExam	Reread CashExam	PDArea CashExam	NextItem BlinkRate CashExam
RTCrimeNeutral	-							
RTCashExam	.022	-						
NFixCrimeNeutral	.949**	.026	-					
NFixCashExam	.032	.902**	.048	-				
FirstPassCashExam	.150	.784**	.182	.854**	-			
RereadCashExam	.079	.773**	.098	.867**	.840**	-		
PDAreaCashExam	-.223*	-.338**	-.262**	-.363**	-.322**	-.292**	-	
NextItemBlinkRate CashExam	.013	-.346**	-.029	-.330**	-.190*	-.209*	.124	-

* $p < .05$, ** $p < .01$

Table 7

Standardized Canonical Discriminant Function Coefficients

Variable	Linear Function
PDCashExam	-.537
FPCashExam	.657
RTCcrimeNeutral	.327
NextItemBlinkRateCashExam	-.305

Table 8

Functions at Group Centroids

Group	Linear Function
Guilty	-.906
Innocent	.906

Table 9

Frequencies (and Percentages) of Cases Correctly Classified with the Linear Discriminant Function

	Actual Group Membership	Predicted Group Membership	
		Guilty	Innocent
Original	Guilty	47 (83.9)	9 (16.1)
	Innocent	6 (10.7)	50 (89.3)
Jackknifed	Guilty	46 (82.1)	10 (17.9)
	Innocent	8 (14.3)	48 (85.7)

The four variables Cook et al. (2008) included in a linear discriminant function also were used to create a linear discriminant function for these data. These four variables included PDCashCard, NFixCashCard, PDCrimeNeutral, and NFixNeutral. Classification rates for the linear function are presented in Table 10. Classification was about 5% lower with the Cook et al. variables than with the four variables selected with stepwise regression in the present study.

Table 10

Frequencies (and Percentages) of Cases Correctly Classified with the Linear Discriminant Function Using Variables from Cook et al. (2008)

	Actual Group Membership	Predicted Group Membership	
		Guilty	Innocent
Original	Guilty	44 (78.6)	12 (21.4)
	Innocent	9 (16.1)	47 (83.9)
Jackknifed	Guilty	43 (76.8)	13 (23.2)
	Innocent	10 (17.9)	46 (82.1)

Objective 3: Effects of Self-Control and Achievement Motivation

Analyses were conducted to determine if self-control or achievement motivation moderate the relationship between guilt and RT and guilt and PD. RT for the difference between cash and exam items, RT for the neutral items, PD for the difference between cash and exam items, and PD for the neutral items were included as dependent variables. Guilt and self-control were centered around their respective means. Each dependent measure was regressed onto guilt, self-control, and their cross-product. The same logic was used to test if achievement motivation moderated the guilt by question type interaction.

The cross-product for guilt and achievement motivation for the difference between RTs for cash and exam items was significant, $p < .05$. This interaction is presented in Figure 9. As compared to guilty subjects low in achievement motivation, innocent subjects low in achievement motivation took longer to respond to the exam items than to the cash items. There was little difference between guilty and innocent subjects high in achievement motivation.

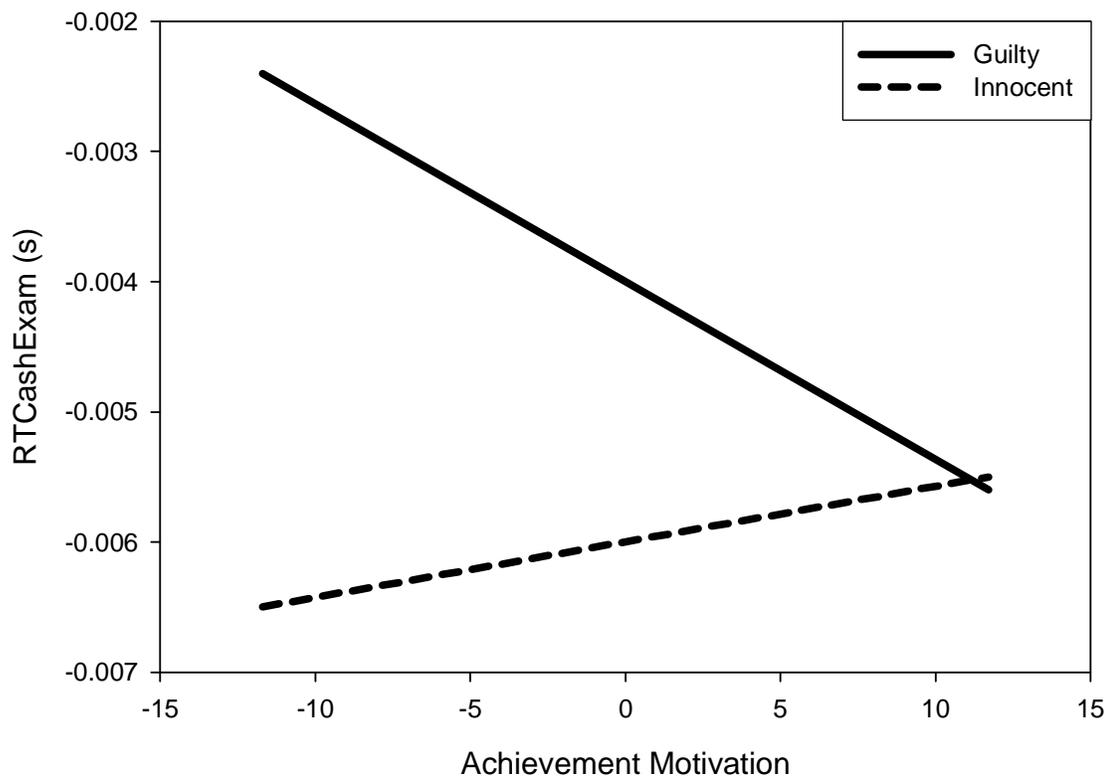


Figure 9. Guilt by achievement motivation interaction for the difference between cash and exam items for RT.

Objective 4: Effects of Guilt, Motivation, and Item Difficulty on Stroop RT and Accuracy

Stroop data from two subjects were lost due to equipment failure, and data from another subject were not collected because the subject was color-blind. Analyses were conducted on the remaining 109 subjects. Mean RTs were computed for correct trials for each stimulus type (incongruent, neutral, and congruent) for each subject. RTs longer than 2000 ms and shorter than 275 ms were discarded (less than 2% of all data). RMANOVAs were performed on Stroop RT and proportion wrong. Stimulus type was the within-subjects factor, and guilt, motivation, item difficulty, and sex were between-subjects factors. Tables that include effects sizes for all significant main effects and interactions are presented in Appendix G.

For RT, the main effect of stimulus type was significant, $F(2,186) = 410.84$. RTs were longest for incongruent items ($M = 841$, $SE = 14.358$), followed by neutral items ($M = 685$, $SE = 11.400$), and congruent items ($M = 625$, $SE = 10.208$). None of the main effects of guilt, motivation, or item difficulty predicted by the regulatory depletion hypothesis materialized.

The three-way interaction between motivation, item difficulty, and sex also was significant, $F(1,93) = 6.93$. This effect is presented in Figures 10a and 10b for females and males, respectively.

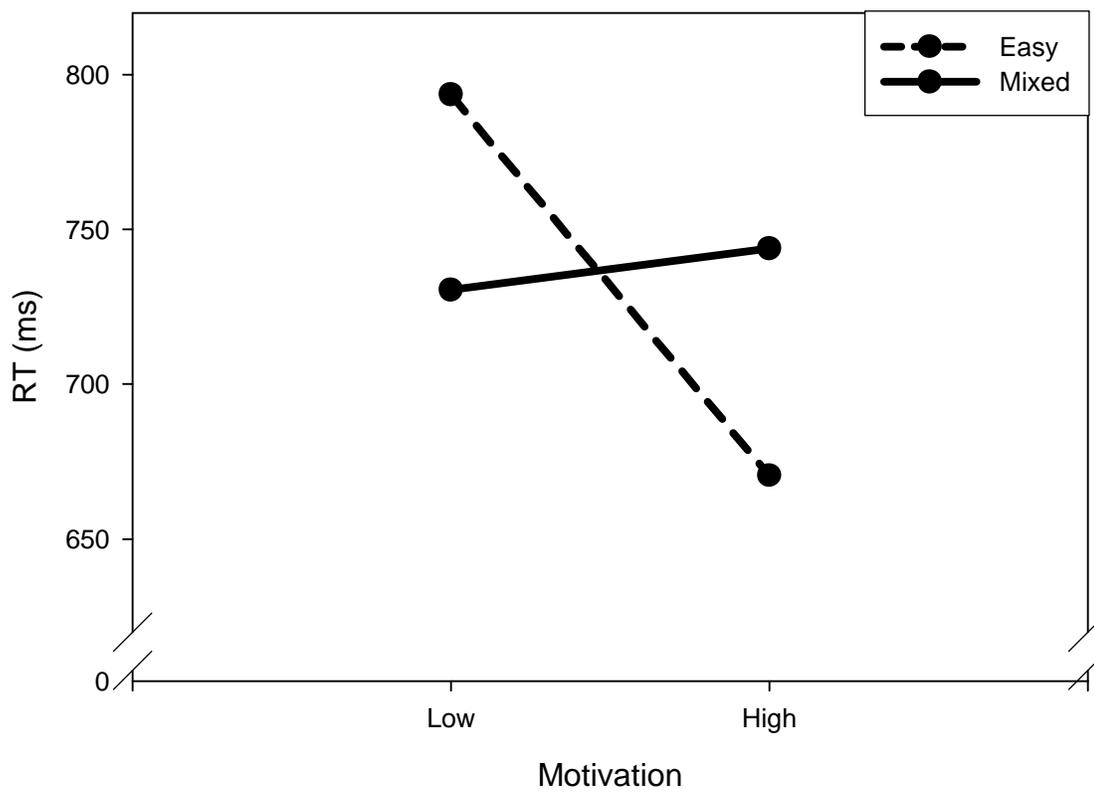


Figure 10a. Stroop RT item difficulty by motivation interaction for females.

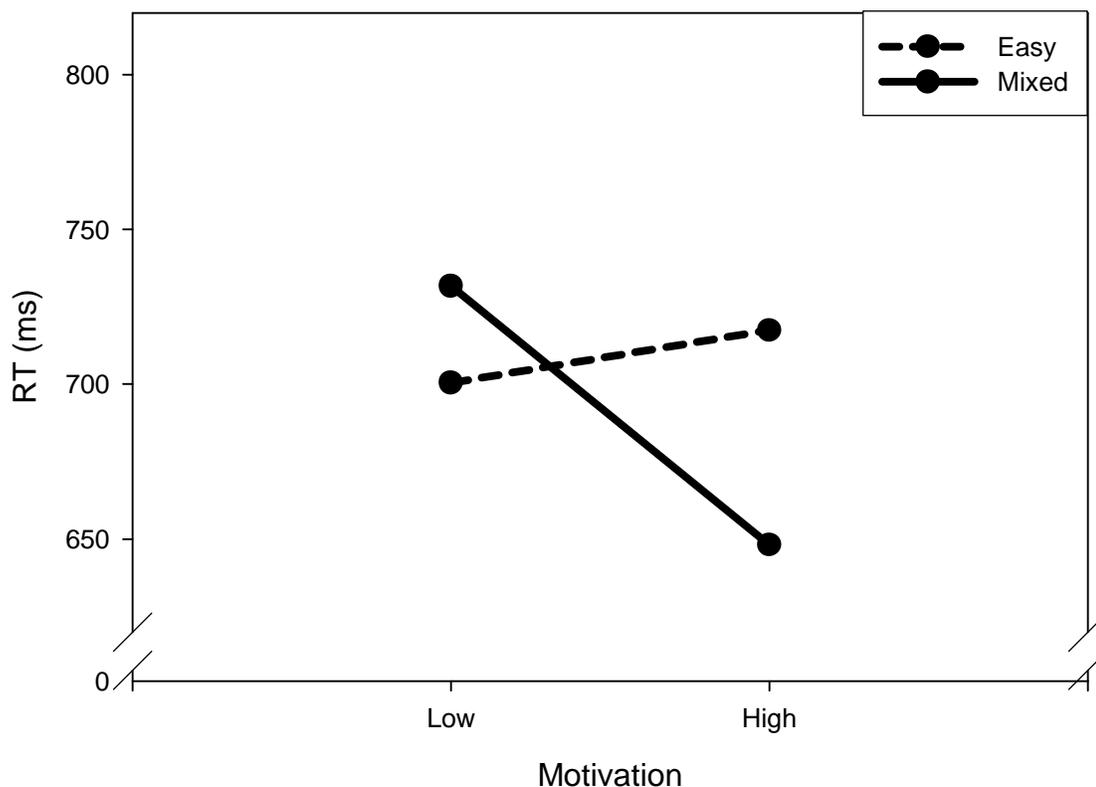


Figure 10b. Stroop RT item difficulty by motivation interaction for males.

Females who were motivated by a large bonus and answered only easy items were faster at naming the ink color of the stimulus than females in the other three conditions. Males who were motivated by a large bonus and who answered mixed T/F items were faster at naming the ink color than males in the other three conditions.

The four-way interaction between motivation, item difficulty, sex, and stimulus type was significant, $F(2,186) = 9.82$, as was the five-way interaction between guilt, motivation, item difficulty, sex, and stimulus type, $F(2,186) = 3.07$.

For proportion wrong for the Stroop task, the main effect of stimulus type was significant, $F(2, 186) = 53.67$. Proportion wrong was highest for incongruent items ($M =$

.076, $SE = .010$), followed by neutral items ($M = .003$, $SE = .002$), and lowest for the congruent items ($M = .002$, $SE = .001$). There were no significant main effects of guilt, motivation, or item difficulty on proportion wrong.

Correlations were computed for Stroop RT, Stroop accuracy, self-control, achievement motivation, and the Acquisitiveness subscale of the achievement motivation scale. The Marlowe-Crowne was partialled out. None of the partial correlations were significant. This suggests self-control and achievement motivation were unrelated to performance on the Stroop task.

Interview Questions

Analyses of variance were performed on two of the interview questions subjects answered at the end of their session: anxiety at the beginning of the experiment and anxiety at the end of the experiment. Guilt, motivation, item difficulty, and sex were included as factors. Guilty subjects ($M = 3.491$, $SE = .157$) were more anxious than innocent subjects ($M = 2.652$, $SE = .157$) at the beginning of the experiment, $F(1,96) = 14.38$, partial $\eta^2 = .130$. Highly motivated subjects ($M = 3.304$, $SE = .157$) were more anxious than less motivated subjects ($M = 2.839$, $SE = .157$) at the beginning of the experiment, $F(1,96) = 4.40$, partial $\eta^2 = .044$. Females ($M = 3.348$, $SE = .157$) were more anxious than males ($M = 2.795$, $SE = .157$) at the beginning of the experiment, $F(1,96) = 6.25$, partial $\eta^2 = .061$.

There were no significant main or interaction effects for anxiety at the end of the experiment, although the guilt by motivation interaction was marginally significant, $F(1,96) = 3.81$, $p = .054$, partial $\eta^2 = .038$. Guilty subjects in the high motivation condition were the most anxious at the end of the experiment ($M = 2.179$, $SE = .188$),

followed by innocent subjects in the low motivation condition ($M = 1.679$, $SE = .188$), innocent subjects in the high motivation condition ($M = 1.571$, $SE = .188$), and guilty subjects in the low motivation condition ($M = 1.554$, $SE = .188$).

Chi-square analyses were conducted to test if responses to the question concerning speed versus accuracy when answering items and responses to the question asking which items were of most concern were related to guilt, motivation, item difficulty, or sex. None of the chi-squares were statistically significant, $ps > .16$.

Subjects were asked how they would have approached the task if a different monetary bonus had been offered to pass the test, what strategies they used to try to pass the test, and how someone else could be taught to beat the test. When asked if they would have acted differently if offered a different monetary bonus (\$1 for subjects in the high motivation condition and \$30 for subjects in the low motivation condition), 58% of subjects stated they would have done nothing differently. For the subjects who stated they would have acted differently, most said they would have tried harder to beat the test to earn the larger bonus or not tried as hard to earn the smaller bonus. When asked if they used any strategies to try to convince the examiner of their innocence, 65% of subjects (44 guilty, 29 innocent) stated they had used strategies. Many stated they tried to be consistent in how they read and answered all items, answered as quickly and accurately as possible, took their time when answering neutral items, and remembered their answers from previous repetitions. Several of the guilty subjects stated that they tried to answer quickly when they were answering the cash items. When asked how they would teach someone else to beat the test, many subjects suggested that others read the

items carefully, be consistent when reading and answering different item types, be calm and focused, and convince themselves of their innocence.

CHAPTER 4

DISCUSSION

The present study evaluated the effects of guilt, motivation, and item difficulty on oculomotor and behavioral measures. Results from the present study generally replicated Cook et al. (2008). Guilty subjects showed the largest PD change to the items concerning a crime they had committed (cash theft), followed by items about a crime they did not commit, and neutral items. As compared to their responses to cash items, guilty subjects took longer to respond, made more fixations, and did more reading and rereading of items concerning the crime they did *not* commit (exam theft) and neutral items. As expected, innocent subjects showed greater PD change to the crime-related items than to the neutral items. Innocent subjects tended to show less difference in oculomotor and behavioral responses to the three item types than did guilty subjects.

Most of the oculomotor and behavioral measures had adequate validity and reliability for discriminating between guilty and innocent groups. These findings replicate Cook et al. (2008) and support the idea that oculomotor measures from a reading task can be used to distinguish between guilty and innocent subjects. Classification rates exceeded 80% for both guilty and innocent groups. Four variables, the difference in PD between the cash and exam items, the difference in first pass duration between the cash and exam items, the difference in RT between the crime and neutral items, and the difference in blink rate between cash and exam items, were

included in the discriminant function. The variables used in Cook et al. (2008) were included in another discriminant function, and classification accuracy was about 5% lower than that reported by Cook et al. The variables used in Cook et al. were optimal for that sample, so it is not surprising that classification was slightly lower when those variables were used in the present study. Nevertheless, the classification rates in both studies suggest that a combination of PD and reading measures can be used to make accurate diagnoses of truth and deception.

For proportion wrong and number of fixations, there was an interaction between guilt and another independent variable. The interaction between guilt and item difficulty for proportion wrong revealed a difference between guilty and innocent subjects only in the easy condition. In the easy condition, guilty subjects made more mistakes than innocent subjects. Proportion wrong was similar for guilty and innocent subjects in the mixed condition. Cook et al. (2008) administered only mixed items and also failed to observe a difference between groups on this measure. This would suggest that administering only easy items could increase differences between guilty and innocent subjects and improve classification accuracy. However, this possibility was not evaluated in the present study because variables were selected for the discriminant analysis that worked well in both easy and mixed conditions, and proportion wrong was diagnostic only for subjects who answered only easy items.

There was an interaction between guilt, question type, and motivation for number of fixations. The pattern of results for the low and high motivation groups was similar for guilty subjects but not for innocent subjects. Innocent subjects in the high motivation group made fewer fixations than guilty subjects on all three item types. In the low

motivation group, innocent subjects made more fixations than guilty subjects on two of the item types. It would appear that innocent subjects in the low motivation group did not modulate their reading behavior as much as did innocent subjects in the high motivation group. The nature of the interaction suggests that innocent subjects were motivated by the monetary bonus, whereas guilty subjects were motivated by the desire to avoid detection.

Decades of research have shown that PD is an indicator of both cognitive effort and emotional arousal (see Loewenfeld, 1999 for a review). It was beyond the scope of the present study to isolate the unique effects of cognitive effort and emotional arousal on PD. An analysis of PD responses to the easy and difficult items within the mixed item difficulty condition indicated a difference between the item types. This suggests that cognitive effort contributes to the effects on PD. However, the data do not rule out the possibility that emotional arousal also might contribute to the effects on PD.

The observed pattern of results is not consistent with basic research on reading. In the field of reading, increases in PD, more fixations, and longer reading times generally are viewed as indications that subjects had greater difficulty processing those items (Rayner, 1998; Rayner, Chace, Slattery, & Ashby, 2006). If deception is more difficult than being truthful, then it should be associated with increased PD and longer reading times. As expected, deception was associated with the greatest increases in PD. However, in comparison to truthful answers, deception also was characterized by fewer fixations and shorter reading and rereading times. Although the pupil data from the present study and Cook et al. (2008) are consistent with the reading literature, the fixation and response time measures are not.

Conservation, as proposed by regulatory depletion theory (Baumeister, 2002; Baumeister, Muraven, & Tice, 2000; Muraven and Baumeister, 2000; Muraven et al., 2006; Muraven & Slessareva, 2003), is one possible explanation for the observed pattern of results. Guilty subjects could have exerted cognitive effort when responding deceptively to ensure they answered quickly and accurately as per the instructions they were given at the start of the experiment. They could have attempted to conserve resources on items answered truthfully by making more fixations and taking more time to read and reread the items.

An alternative explanation is that the information pertaining to the cash crime was retrieved more easily than information related to the exam crime. Work by Michael Anderson and colleagues (Anderson & Bell, 2001; Anderson, Bjork, & Bjork, 1994) has shown that retrieving information from long-term memory can adversely affect recall of related information. Anderson et al. (1994) had subjects study several different categories. Some of the category members then were practiced with retrieval tests. Results showed that recall of the category members that were not practiced suffered. In the present study, guilty subjects could easily retrieve information that pertained to the cash crime because they had committed the crime, were familiar with the details, and knew they had to appear truthful when answering to receive the monetary bonus. Details that pertained to the exam crime were not as practiced as those that pertained to the cash crime because guilty subjects did not commit that crime and were not as familiar with it. Perhaps answering questions that pertained to the cash crime and retrieving information related to that crime adversely affected guilty subjects' performance on the exam and

neutral items. However, this explanation does not account for the effects on PD, unless the effects on PD were due to emotional arousal.

One of the objectives was to determine if self-control or achievement motivation moderate the relationship between guilt and RT or guilt and PD. As compared to guilty subjects low in achievement motivation, innocent subjects low in achievement motivation took longer to respond to the exam items than to the cash items. For subjects high in achievement motivation, there was little difference between guilty and innocent subjects in RT to the cash and exam items. This finding suggests that a reading test for deception might be more effective for subjects low in achievement motivation than for subjects high in achievement motivation.

Although regulatory depletion theory might explain why guilty subjects took longer to answer when they were truthful than when they were deceptive, the theory predicted a number of differences on the Stroop task that were not confirmed. Specifically, self-regulatory resources should have been more depleted for guilty subjects than for innocent subjects, and resources should have been more depleted for subjects who answered mixed items than for subjects who answered only easy items. None of the tests for main effects of guilt, motivation, or item difficulty on Stroop RT and accuracy were significant.

Although the main effect of motivation was not significant, highly motivated subjects generally performed well. There was a significant interaction between item difficulty, motivation, and sex on Stroop RT. Highly motivated males who answered the mixed T/F items performed best on the Stroop task. Females who were offered the \$1 bonus and answered only easy T/F items performed worst. Subjects who answered a

combination of easy and difficult items prior to the Stroop task should have depleted available resources for self-control and performed poorly on the Stroop. However, males in this condition who were highly motivated performed well on the Stroop task. It would appear that offering a large bonus to depleted male subjects helps them improve their performance on the Stroop task. Work by Baumeister, Vohs, and Tice (2007) and Muraven and Slessareva (2003) has shown that subjects can overcome the effects of depletion when offered a monetary incentive. The monetary bonus may have moderated the effects of depletion for males in the present study.

Effects of self-control and achievement motivation on Stroop RT and accuracy also were evaluated. Self-control and achievement motivation were unrelated to performance on the Stroop task. Scores on the Acquisitiveness subscale of the achievement motivation scale also were not related to Stroop performance. There may be no relationship between these individual difference variables and Stroop performance, or the questionnaires may not have adequately measured the constructs.

Limitations

The present study was a laboratory experiment. These techniques may be more or less effective in field situations where subjects are more highly motivated and personally involved in the outcome of the test, but high levels of experimental control are often difficult to achieve.

Effort was made to ensure that the arousal value and complexity of items concerning the cash and exam crimes were similar. However, results suggest that the exam items were not equal to the cash items. Innocent subjects answered cash and exam items truthfully, and innocent subjects tended to have larger responses to the exam items

than to the cash items. There could have been differences due to the wording of the items, or due to perceived differences between the crimes. For a student, a crime involving a theft from a professor's office may have been considered more serious than a theft of money from a secretary, and they may have been more concerned about being accused of that crime.

Another limitation was that the sample consisted mostly of single Caucasian college students. This sample is representative of the University of Utah population, but generalizability to the general population may be limited. If this type of test is to be used in a security screening situation, it is important to ensure the results generalize to the populations of interest.

Although self-control and achievement motivation measures were unrelated to the various outcome measures, they may have been inadequate measures of the constructs they were designed to measure.

Implications and Future Directions

Results from the present study and Cook et al. (2008) suggest that a combination of behavioral and oculomotor measures can be used to detect deception. These results were found in a mock-crime study similar to a forensic situation but also have potential for use in a security screening situation. In a security screening situation, subjects are asked questions about several issues, and they may or may not be deceptive about one or more issues on the test. Future work should test if there are advantages or disadvantages to adding issues to the test.

Results from the present study suggest eye blinks have promise as a measure of deception. The effect size for blinks was small, but it is a measure that deserves further

study, especially since it is relatively independent from the other oculomotor and behavioral measures used in the present study.

In the present study, subjects were told to answer as quickly and accurately as possible to ensure that they did not appear deceptive on the test. Future work could eliminate this instruction. The effects observed in Cook et al. (2008) and the present study may be attenuated if subjects are not told to answer as quickly and accurately as they can. Responses to the open-ended interview questions indicated that this instruction was salient to subjects, so it would be informative to see if behavior changes without that instruction.

Summary

Guilty subjects showed large PD change to items to which they were deceptive, and they took longer to respond, made more fixations, and spent more time reading and rereading items to which they were truthful. Innocent subjects showed less difference to the three item types than did guilty subjects. Several behavioral and oculomotor measures were diagnostic of deception, and a weighted combination of four of those variables correctly classified 84% of guilty and 89% of innocent subjects. Achievement motivation moderated the relationship between guilt and RT for the difference between the cash and exam items. As compared to guilty subjects, innocent subjects low in achievement motivation took longer to respond to the exam items than to the cash items. Subjects high in achievement motivation showed less difference in RT to cash and exam items. Self-control and achievement motivation did not affect Stroop RT or accuracy. Future work should examine the effects of increasing the number of issues covered by the test and the importance of the speed/accuracy instruction.

APPENDIX A

T/F ITEMS

Mixed Items

Neutral Items

True/Positive

I was born prior to the year 1990.

The sky is blue on sunny days.

I attend a university that is in the United States.

The snow that accumulates in the winter melts in the spring.

True/Negative

I am reading this on a day other than Sunday.

Polar bears do not roam freely in Mexico.

I have eyes that are most definitely not the color orange.

The season that follows summer is not spring.

False/Positive

I am reading this sentence on March 12, 2002.

San Francisco is in the state of Nevada.

I drive a car that runs on only air and water.

The Congo is a country that I visit several times a week.

False/Negative

I have never listened to radio or watched TV.

Whales do not live in any of the world's oceans.

I reside in a city that is not located in the state of Utah.

Trees that grow in the forest are never harvested for lumber.

Cash Items

True/Positive

I was uninvolved in the theft of the twenty dollars.

The wallet in the office was untouched by me.

I am innocent of taking the item that was in the purse.

The claim that I stole from a secretary is incorrect.

True/Negative

I did not take anything from the wallet in the office.

The theft involving the purse was not my fault.

I did not take anything that was in the secretary's office.

The twenty dollars that was in the office is not in my possession.

False/Positive

I am guilty of taking something from the secretary's office.

The reason the twenty dollars is gone is because I took it.

I admit to stealing the item that was in the purse.

The claim that I tampered with the wallet in the office is valid.

False/Negative

I am not innocent of stealing the twenty dollars.

The wallet was not recently tampered with by anyone but me.

I did not leave the office until I had taken the item that was in the purse.

The claim that I did not take anything from the secretary is incorrect.

Exam Items

True/Positive

I took nothing from the professor's office.

The disk was untouched by me.

I left alone the information that was on the computer.

The exam that was in the office was left alone by me.

True/Negative

I did not take the exam from the office.

The information was not copied to a disk by me.

I never copied the information that was on the computer.

The claim that I copied the professor's information is not correct.

False/Positive

I made a copy of the professor's information.

The disk in my possession contains the copied information.

I have a copy of the information that was on the computer.

The exam that was in the office is in my possession.

False/Negative

I am not innocent of copying the information to a disk.

The loss of the exam is no one's fault but mine.

I did not pass up the chance to copy the information that was on the computer.

The claim that I made a copy of the professor's information is not wrong.

Easy Items

Neutral Items

True

I was born prior to the year 1990.

The sky is blue on sunny days.

Cats and dogs are often kept as pets.

Dinosaurs used to roam the earth.

I am reading this on a day other than Sunday.

Polar bears do not roam freely in Mexico.

Global warming is a concern for many people.

Large SUVs often get lower gas mileage than newer compact cars.

False

I am reading this sentence on March 12, 2002.

San Francisco is in the state of Nevada.

There are only 35 states in the United States.

Road construction is fast and convenient for motorists.

I have never listened to radio or watched TV.

Whales do not live in any of the world's oceans.

Trees are never harvested for lumber.

Morbid obesity is not a health concern in the United States.

Cash Items

True

I was uninvolved in the theft of the twenty dollars.

The wallet in the office was untouched by me.

I did not take anything from the wallet in the office.

The theft involving the purse was not my fault.

The secretary's property was not stolen by me.

I am innocent of taking the secretary's property from the office.

I had nothing to do with the theft of the twenty dollars.

The article from the purse was not stolen by me.

False

I am guilty of taking something from the secretary's office.

The reason the twenty dollars is gone is because I took it.

I am not innocent of stealing the twenty dollars.

The wallet was not recently tampered with by anyone but me.

The item from the purse is hidden on my person.

I removed something from the purse in the office.

The secretary's property was stolen by me.

I know what happened to the item missing from the wallet.

Exam Items

True

I took nothing from the professor's office.

The disk was untouched by me.

I did not take the exam from the office.

The information was not copied to a disk by me.

The loss of the professor's information is not my fault.

The information from the computer is not in my possession.

I did not take anything from the computer in the office.

I am not guilty of taking the exam from the office.

False

I made a copy of the professor's information.

The disk in my possession contains the copied information.

I am not innocent of copying the information to a disk.

The loss of the exam is no one's fault but mine.

I took the information from the computer in the office.

The professor's information is missing because of me.

The missing exam is in my possession.

I copied the information from the computer.

APPENDIX B

DEMOGRAPHIC QUESTIONNAIRE

Demographic Questionnaire

Participant ID # _____

1. Age: _____
2. Sex: (circle one) Male Female
3. Marital status: (circle one)
Single
Married
Divorced
Widowed
Separated
4. Racial/Ethnic Origin: (circle one)
African American
Asian
South Pacific Islander
Latino/a
American Indian
Middle Eastern
Caucasian
Other (please explain): _____
5. What is your status? (circle one)
Student
Staff
Other
6. If you are a student, what is your college major? _____
7. If you are a student, what is your class standing? (circle one)
Freshman
Sophomore
Junior
Senior
Graduate
8. If you are a student, what is your enrollment status? (circle one)
Full-time

Part-time

Other (please explain): _____

9. If you are a student, what is your current GPA? _____

10. If you are not a student, what is the highest level of school or degree you have completed? (circle one)

High school

Trade school

Associate's degree

Bachelor's degree

Master's degree

Professional degree

Doctorate degree

11. Is English your primary language? (circle one) Yes No

If you circled No, what is your primary language? _____

12. Do you wear any of the following for vision correction for reading? (circle one)

Glasses

Contacts

Neither

APPENDIX C

SELF-CONTROL SCALE

	Not at all			Very much	
	1	2	3	4	5
1. I am good at resisting temptation.	1	2	3	4	5
2. I have a hard time breaking bad habits.*	1	2	3	4	5
3. I am lazy.*	1	2	3	4	5
4. I say inappropriate things.*	1	2	3	4	5
5. I never allow myself to lose control.	1	2	3	4	5
6. I do certain things that are bad for me, if they are fun.*	1	2	3	4	5
7. People can count on me to keep on schedule.	1	2	3	4	5
8. Getting up in the morning is hard for me.*	1	2	3	4	5
9. I have trouble saying no.*	1	2	3	4	5
10. I change my mind fairly often.*	1	2	3	4	5
11. I blurt out whatever is on my mind.*	1	2	3	4	5
12. People would describe me as impulsive.*	1	2	3	4	5
13. I refuse things that are bad for me.	1	2	3	4	5
14. I spend too much money.*	1	2	3	4	5
15. I keep everything neat.	1	2	3	4	5
16. I am self-indulgent at times.*	1	2	3	4	5
17. I wish I had more self-discipline.*	1	2	3	4	5
18. I am reliable.	1	2	3	4	5
19. I get carried away by my feelings.*	1	2	3	4	5
20. I do many things on the spur of the moment.*	1	2	3	4	5
21. I don't keep secrets very well.*	1	2	3	4	5
22. People would say that I have iron self-discipline.	1	2	3	4	5
23. I have worked or studied all night at the last minute.*	1	2	3	4	5
24. I'm not easily discouraged.	1	2	3	4	5
25. I'd be better off if I stopped to think before acting.*	1	2	3	4	5
26. I engage in healthy practices.	1	2	3	4	5
27. I eat healthy foods.	1	2	3	4	5
28. Pleasure and fun sometimes keep me from getting work done.*	1	2	3	4	5
29. I have trouble concentrating.*	1	2	3	4	5
30. I am able to work effectively toward long-term goals.	1	2	3	4	5
31. Sometimes I can't stop myself from doing something, even if I know it is wrong.*	1	2	3	4	5
32. I often act without thinking through all of the alternatives.*	1	2	3	4	5
33. I lose my temper too easily.*	1	2	3	4	5
34. I often interrupt people.*	1	2	3	4	5
35. I sometimes drink or use drugs to excess.*	1	2	3	4	5
36. I am always on time.	1	2	3	4	5

* indicates an item that is reverse scored.

APPENDIX D

CASSIDY-LYNN ACHIEVEMENT MOTIVATION QUESTIONNAIRE

Factor 1: Work Ethic

- | | | | |
|--|-----|----|------------|
| 1. Hard work is something I like to avoid. | Yes | No | Don't Know |
| 2. I can easily sit for a long time doing nothing. | Yes | No | Don't Know |
| 3. I must admit I often do as little work as I can get away with. | Yes | No | Don't Know |
| 4. I am basically a lazy person. | Yes | No | Don't Know |
| 5. I often put off until tomorrow things I know I should do today. | Yes | No | Don't Know |
| 6. I easily get bored if I don't have something to do. | Yes | No | Don't Know |
| 7. I like to work hard. | Yes | No | Don't Know |

Factor 2: Acquisitiveness

- | | | | |
|--|-----|----|------------|
| 8. If there is an opportunity to earn money, I am usually there. | Yes | No | Don't Know |
| 9. I would be willing to work for a salary that was below average if the job was pleasant. | Yes | No | Don't Know |
| 10. The kind of work I like is the one that pays top salary for top performance. | Yes | No | Don't Know |
| 11. As long as I'm paid for my work, I don't mind working while others are having fun. | Yes | No | Don't Know |
| 12. I frequently think about that I might do to earn a great deal of money. | Yes | No | Don't Know |
| 13. It is important to me to make lots of money. | Yes | No | Don't Know |
| 14. The most important thing about a job is the pay. | Yes | No | Don't Know |

Factor 3: Dominance

- | | | | |
|--|-----|----|------------|
| 15. I think I would enjoy having authority over other people. | Yes | No | Don't Know |
| 16. If given the chance I would make a good leader of people. | Yes | No | Don't Know |
| 17. I think I am usually a leader in my group. | Yes | No | Don't Know |
| 18. I enjoy planning things and deciding what other people should do. | Yes | No | Don't Know |
| 19. I like to give orders and get things going. | Yes | No | Don't Know |
| 20. People take notice of what I say. | Yes | No | Don't Know |
| 21. When a group I belong to plans an activity I would rather direct it myself than just help out and have someone else organize it. | Yes | No | Don't Know |

Factor 4: Excellence

- | | | | |
|--|-----|----|------------|
| 22. I hate to see bad workmanship. | Yes | No | Don't Know |
| 23. Part of the satisfaction of doing something comes from seeing how good the finished product looks. | Yes | No | Don't Know |
| 24. It is no use playing a game when you are playing with someone as good as yourself. | Yes | No | Don't Know |
| 25. I get a sense of satisfaction out of being able to say I have done a very good job on a project. | Yes | No | Don't Know |

26. I find satisfaction in working as well as I can.	Yes	No	Don't Know
27. I find satisfaction in exceeding my previous performance even if I don't outperform others.	Yes	No	Don't Know
28. There is satisfaction in a job well done.	Yes	No	Don't Know
Factor 5: Competitiveness			
29. I try harder when I'm in competition with other people.	Yes	No	Don't Know
30. It annoys me when other people perform better than I do.	Yes	No	Don't Know
31. I judge my performance on whether I do better than others rather than on just getting a good result.	Yes	No	Don't Know
32. If I get a good result, it doesn't matter if others do better.	Yes	No	Don't Know
33. I would never allow others to get the credit for what I have done.	Yes	No	Don't Know
34. To be a real success I feel I have to do better than everyone I come up against.	Yes	No	Don't Know
35. It is important to me to perform better than others on a task.	Yes	No	Don't Know
Factor 6: Status Aspiration			
36. I would like an important job where people looked up to me.	Yes	No	Don't Know
37. I like talking to people who are important.	Yes	No	Don't Know
38. I want to be an important person in the community.	Yes	No	Don't Know
39. I like to be admired for my achievements.	Yes	No	Don't Know
40. I dislike being the center of attention.	Yes	No	Don't Know
41. I like to have people come to me for advice.	Yes	No	Don't Know
42. I find satisfaction in having influence over others because of my position in the community.	Yes	No	Don't Know
Factor 7: Mastery			
43. I would rather do something at which I feel confident and relaxed than something which is challenging and difficult.	Yes	No	Don't Know
44. I would rather learn easy fun games than difficult thought games.	Yes	No	Don't Know
45. If I'm not good at something I would rather keep struggling to master it than move on to something I may be good at.	Yes	No	Don't Know
46. I prefer to work in situations that require a high level of skill.	Yes	No	Don't Know
47. I more often attempt tasks I am not sure I can do than tasks I know I can do.	Yes	No	Don't Know
48. I like to be busy all the time.	Yes	No	Don't Know
49. I feel like giving up quickly when things go wrong.	Yes	No	Don't Know

APPENDIX E

MARLOWE-CROWNE SOCIAL DESIRABILITY SCALE

- | | | |
|--|------|-------|
| 1. I have never deliberately said something that hurt someone's feelings. (True) | True | False |
| 2. Before voting I thoroughly investigate the qualifications of all the candidates. (True) | True | False |
| 3. I never hesitate to go out of my way to help someone in trouble. (True) | True | False |
| 4. It is sometimes hard for me to go on with my work if I am not encouraged. (False) | True | False |
| 5. I have never intensely disliked anyone. (True) | True | False |
| 6. On occasion I have had doubts about my ability to succeed in life. (False) | True | False |
| 7. I sometimes feel resentful when I don't get my way. (False) | True | False |
| 8. I am always careful about my manner of dress. (True) | True | False |
| 9. My table manners at home are as good as when I eat out in a restaurant. (True) | True | False |
| 10. If I could get into a movie without paying and be sure I was not seen I would probably do it. (False) | True | False |
| 11. On a few occasions, I have given up doing something because I thought too little of my ability. (False) | True | False |
| 12. I like to gossip at times. (False) | True | False |
| 13. There have been times when I felt like rebelling against people in authority even though I knew they were right. (False) | True | False |
| 14. No matter who I'm talking to, I'm always a good listener. (True) | True | False |
| 15. I can remember "playing sick" to get out of something. (False) | True | False |
| 16. There have been occasions when I took advantage of someone. (False) | True | False |
| 17. I'm always willing to admit it when I make a mistake. (True) | True | False |
| 18. I always try to practice what I preach. (True) | True | False |
| 19. I don't find it particularly difficult to get along with loud mouthed, obnoxious people. (True) | True | False |
| 20. I sometimes try to get even rather than forgive and forget. (False) | True | False |
| 21. When I don't know something I don't at all mind admitting it. (True) | True | False |
| 22. I am always courteous, even to people who are disagreeable. (True) | True | False |
| 23. At times I have really insisted on having things my own way. (False) | True | False |
| 24. There have been occasions when I felt like smashing things. (False) | True | False |
| 25. I would never think of letting someone else be punished for my wrong-doings. (True) | True | False |
| 26. I never resent being asked to return a favor. (True) | True | False |
| 27. I have never been irked when people expressed ideas very different from my own. (True) | True | False |
| 28. I never make a long trip without checking the safety of my car. (True) | True | False |
| 29. There have been times when I was quite jealous of the good fortune of others. (False) | True | False |
| 30. I have almost never felt the urge to tell someone off. (True) | True | False |
| 31. I am sometimes irritated by people who ask favors of me. (False) | True | False |
| 32. I have never felt that I was punished without cause. (True) | True | False |
| 33. I sometimes think when people have a misfortune they only got | True | False |

what they deserved. (False)

APPENDIX F

INTERVIEW QUESTIONS

APPENDIX G

EFFECT SIZES FOR EACH DEPENDENT VARIABLE

Table 11
Effect Sizes for Response Time

Source	Effect Size
Guilt	.052
Motiv	--
Item	--
Sex	--
Rep	.567
QT	.277
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	.041
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	--
Rep x Motiv	--
Rep x Item	--
Rep x Sex	--
Rep x QT	.068
QT x Guilt	.142
QT x Motiv	--
QT x Item	.067
QT x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Rep x Guilt x Motiv	--
Rep x Guilt x Item	--

Table 11 Continued

Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	--
Rep x QT x Item	.024
Rep x QT x Sex	--
QT x Guilt x Motiv	--
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	--
QT x Motiv x Sex	--
QT x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	--
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	--
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	--
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--

Table 11 Continued

Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	--
Rep x QT x Guilt x Item x Sex	--
Rep x QT x Motiv x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 12
Effect Sizes for Proportion Wrong

Source	Effect Size
Guilt	.055
Motiv	--
Item	--
Sex	--
Rep	.124
QT	.146
Guilt x Motiv	--
Guilt x Item	.046
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	--
Rep x Motiv	--
Rep x Item	--
Rep x Sex	--
Rep x QT	.044
QT x Guilt	--
QT x Motiv	--
QT x Item	.077
QT x Sex	.047
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Rep x Guilt x Motiv	--
Rep x Guilt x Item	--

Table 12 Continued

Rep x Motiv x Item	.026
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	--
Rep x QT x Item	--
Rep x QT x Sex	--
QT x Guilt x Motiv	--
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	--
QT x Motiv x Sex	--
QT x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	--
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	--
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	--
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--

Table 12 Continued

Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	.027
Rep x QT x Guilt x Item x Sex	--
Rep x QT x Motiv x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 13
Effect Sizes for Number of Fixations

Source	Effect Size
Guilt	--
Motiv	--
Item	.047
Sex	--
Rep	.540
QT	.185
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	--
Rep x Motiv	--
Rep x Item	--
Rep x Sex	--
Rep x QT	.069
QT x Guilt	.173
QT x Motiv	--
QT x Item	.086
QT x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Rep x Guilt x Motiv	--
Rep x Guilt x Item	--

Table 13 Continued

Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	--
Rep x QT x Item	.028
Rep x QT x Sex	--
QT x Guilt x Motiv	.034
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	--
QT x Motiv x Sex	--
QT x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	--
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	--
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	--
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--

Table 13 Continued

Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	--
Rep x QT x Guilt x Item x Sex	--
Rep x QT x Motiv x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 14
Effect Sizes for First Pass Duration

Source	Effect Size
Guilt	--
Motiv	--
Item	--
Sex	.038
Rep	.282
QT	.273
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	--
Rep x Motiv	--
Rep x Item	--
Rep x Sex	--
Rep x QT	.086
QT x Guilt	.163
QT x Motiv	--
QT x Item	.096
QT x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Rep x Guilt x Motiv	--
Rep x Guilt x Item	--

Table 14 Continued

Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	--
Rep x QT x Item	--
Rep x QT x Sex	--
QT x Guilt x Motiv	--
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	--
QT x Motiv x Sex	--
QT x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	--
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	--
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	.042
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--

Table 14 Continued

Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	--
Rep x QT x Guilt x Item x Sex	.027
Rep x QT x Motiv x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 15
Effect Sizes for Reread Duration

Source	Effect Size
Guilt	.047
Motiv	--
Item	--
Sex	--
Rep	.505
QT	.325
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	--
Rep x Motiv	--
Rep x Item	--
Rep x Sex	.026
Rep x QT	.040
QT x Guilt	.136
QT x Motiv	--
QT x Item	.086
QT x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	.040
Rep x Guilt x Motiv	--
Rep x Guilt x Item	--

Table 15 Continued

Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	--
Rep x QT x Item	--
Rep x QT x Sex	--
QT x Guilt x Motiv	--
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	--
QT x Motiv x Sex	--
QT x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	.028
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	--
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	--
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--

Table 15 Continued

Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	--
Rep x QT x Guilt x Item x Sex	--
Rep x QT x Motiv x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 16
Effect Sizes for Pupil Diameter

Source	Effect Size
Guilt	--
Motiv	--
Item	--
Sex	--
Rep	.042
QT	.535
Time	.056
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	.034
Rep x Motiv	--
Rep x Item	--
Rep x Sex	--
Rep x QT	.071
Rep x Time	.017
QT x Guilt	.157
QT x Motiv	.044
QT x Item	--
QT x Sex	--
QT x Time	.467
Time x Guilt	--
Time x Motiv	--
Time x Item	--

Table 16 Continued

Time x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Rep x Guilt x Motiv	--
Rep x Guilt x Item	--
Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Guilt x Motiv	--
Rep x Guilt x Item	--
Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	--
Rep x QT x Item	--
Rep x QT x Sex	--
Rep x QT x Time	.043
Rep x Time x Guilt	--
Rep x Time x Motiv	--
Rep x Time x Item	--
Rep x Time x Sex	.021
QT x Guilt x Motiv	--
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	--

Table 16 Continued

QT x Motiv x Sex	--
QT x Item x Sex	--
QT x Time x Guilt	.104
QT x Time x Motiv	--
QT x Time x Item	--
QT x Time x Sex	--
Time x Guilt x Motiv	--
Time x Guilt x Item	--
Time x Motiv x Item	--
Time x Guilt x Sex	--
Time x Motiv x Sex	--
Time x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	--
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	--
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
Rep x Time x Guilt x Motiv	--
Rep x Time x Guilt x Item	--
Rep x Time x Motiv x Item	--
Rep x Time x Guilt x Sex	--
Rep x Time x Motiv x Sex	--
Rep x Time x Item x Sex	--

Table 16 Continued

Rep x QT x Time x Guilt	.021
Rep x QT x Time x Motiv	--
Rep x QT x Time x Item	--
Rep x QT x Time x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	--
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--
QT x Time x Guilt x Motiv	--
QT x Time x Guilt x Item	--
QT x Time x Motiv x Item	--
QT x Time x Guilt x Sex	--
QT x Time x Motiv x Sex	--
QT x Time x Item x Sex	--
Time x Guilt x Motiv x Item	--
Time x Guilt x Motiv x Sex	.042
Time x Guilt x Item x Sex	--
Time x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	--
Rep x QT x Guilt x Item x Sex	--
Rep x QT x Motiv x Item x Sex	--
Rep x Time Guilt x Motiv x Item	--
Rep x Time x Guilt x Motiv x Sex	--
Rep x Time x Guilt x Item x Sex	--
Rep x Time x Motiv x Item x Sex	--
Rep x QT x Time x Guilt x Motiv	--
Rep x QT x Time x Guilt x Item	--

Table 16 Continued

Rep x QT x Time x Motiv x Item	--
Rep x QT x Time x Guilt x Sex	--
Rep x QT x Time x Motiv x Sex	--
Rep x QT x Time x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
QT x Time x Guilt x Motiv x Item	--
QT x Time x Guilt x Motiv x Sex	--
QT x Time x Guilt x Item x Sex	--
QT x Time x Motiv x Item x Sex	--
Time x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--
Rep x Time x Guilt x Motiv x Item x Sex	--
QT x Time x Guilt x Motiv x Item x Sex	--
Rep x QT x Time x Guilt x Motiv x Item	--
Rep x QT x Time x Guilt x Motiv x Sex	--
Rep x QT x Time x Guilt x Item x Sex	--
Rep x QT x Time x Guilt x Motiv x Item x Sex	--
Rep x QT x Time x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 17
Effect Sizes for Item Blink Rate

Source	Effect Size
Guilt	--
Motiv	--
Item	--
Sex	--
Rep	--
QT	--
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	--
Rep x Motiv	--
Rep x Item	--
Rep x Sex	--
Rep x QT	--
QT x Guilt	--
QT x Motiv	--
QT x Item	--
QT x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Rep x Guilt x Motiv	.027
Rep x Guilt x Item	--

Table 17 Continued

Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	--
Rep x QT x Item	--
Rep x QT x Sex	--
QT x Guilt x Motiv	--
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	.039
QT x Motiv x Sex	--
QT x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	--
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	--
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	--
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--

Table 17 Continued

Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	--
Rep x QT x Guilt x Item x Sex	--
Rep x QT x Motiv x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 18
Effect Sizes for Next Item Blink Rate

Source	Effect Size
Guilt	--
Motiv	--
Item	--
Sex	--
Rep	--
QT	--
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Rep x Guilt	--
Rep x Motiv	--
Rep x Item	--
Rep x Sex	--
Rep x QT	--
QT x Guilt	.044
QT x Motiv	--
QT x Item	--
QT x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Rep x Guilt x Motiv	.028
Rep x Guilt x Item	--

Table 18 Continued

Rep x Motiv x Item	--
Rep x Guilt x Sex	--
Rep x Motiv x Sex	--
Rep x Item x Sex	--
Rep x QT x Guilt	--
Rep x QT x Motiv	.021
Rep x QT x Item	--
Rep x QT x Sex	--
QT x Guilt x Motiv	--
QT x Guilt x Item	--
QT x Motiv x Item	--
QT x Guilt x Sex	--
QT x Motiv x Sex	--
QT x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Rep x Guilt x Motiv x Item	--
Rep x Guilt x Motiv x Sex	--
Rep x Guilt x Item x Sex	--
Rep x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv	--
Rep x QT x Guilt x Item	.020
Rep x QT x Motiv x Item	--
Rep x QT x Guilt x Sex	--
Rep x QT x Motiv x Sex	--
Rep x QT x Item x Sex	--
QT x Guilt x Motiv x Item	--
QT x Guilt x Motiv x Sex	--
QT x Guilt x Item x Sex	--
QT x Motiv x Item x Sex	--

Table 18 Continued

Rep x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item	--
Rep x QT x Guilt x Motiv x Sex	--
Rep x QT x Guilt x Item x Sex	--
Rep x QT x Motiv x Item x Sex	--
QT x Guilt x Motiv x Item x Sex	--
Rep x QT x Guilt x Motiv x Item x Sex	--

Rep = repetition, Motiv = motivation, Item = item difficulty, QT = question type

Table 19
Effect Sizes for Stroop Response Time

Source	Effect Size
Guilt	--
Motiv	--
Item	--
Sex	--
Stimtype	.815
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Stimtype x Guilt	--
Stimtype x Motiv	--
Stimtype x Item	--
Stimtype x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	.069
Stimtype x Guilt x Motiv	--
Stimtype x Guilt x Item	--
Stimtype x Guilt x Sex	--
Stimtype x Motiv x Item	--
Stimtype x Motiv x Sex	--
Stimtype x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Stimtype x Guilt x Motiv x Item	--

Table 19 Continued

Stimtype x Guilt x Motiv x Sex	--
Stimtype x Guilt x Item x Sex	--
Stimtype x Motiv x Item x Sex	.096
Stimtype x Guilt x Motiv x Item x Sex	.032

Stimtype = stimulus type, Motiv = motivation, Item = item difficulty

Table 20
Effect Sizes for Stroop Proportion Wrong

Source	Effect Size
Guilt	--
Motiv	--
Item	--
Sex	--
Stimtype	.366
Guilt x Motiv	--
Guilt x Item	--
Guilt x Sex	--
Motiv x Item	--
Motiv x Sex	--
Item x Sex	--
Stimtype x Guilt	--
Stimtype x Motiv	--
Stimtype x Item	--
Stimtype x Sex	--
Guilt x Motiv x Item	--
Guilt x Motiv x Sex	--
Guilt x Item x Sex	--
Motiv x Item x Sex	--
Stimtype x Guilt x Motiv	--
Stimtype x Guilt x Item	--
Stimtype x Guilt x Sex	--
Stimtype x Motiv x Item	--
Stimtype x Motiv x Sex	--
Stimtype x Item x Sex	--
Guilt x Motiv x Item x Sex	--
Stimtype x Guilt x Motiv x Item	--

Table 20 Continued

Stimtype x Guilt x Motiv x Sex	--
Stimtype x Guilt x Item x Sex	--
Stimtype x Motiv x Item x Sex	--
Stimtype x Guilt x Motiv x Item x Sex	--

Stimtype = stimulus type, Motiv = motivation, Item = item difficulty

REFERENCES

- Ahern S., & Beatty, J. (1979). Pupillary responses during information processing vary with Scholastic Aptitude Test scores. *Science*, *205*, 1289-1292.
- Anderson, M. C., & Bell, T. (2001). Forgetting our facts: The role of inhibitory processes in the loss of propositional knowledge. *Journal of Experimental Psychology: General*, *130*, 544-570.
- Anderson, M. C., Bjork, R. A., & Bjork, E. L. (1994). Remembering can cause forgetting: Retrieval dynamics in long-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*, 1063-1087.
- Baker, L., Stern, J. A., & Goldstein, R. (1992). *The gaze control system and the detection of deception*. Final Report to the U. S. Government for Contract #90-F131400. Department of Psychology, Washington University, St. Louis, MO.
- Baumeister, R. F. (2002). Ego-depletion and self-control failure: An energy model of the self's executive function. *Self and Identity*, *1*, 129-136.
- Baumeister, R. F., Bratlavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the self a limited resource? *Journal of Personality and Social Psychology*, *74*, 1252-1265.
- Baumeister, R. F., Muraven, M., & Tice, D. M. (2000). Ego depletion: a resource model of volition, self-regulation, and controlled processing. *Social Cognition*, *18*, 130-150.
- Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science*, *16*, 351-355.
- Beatty, J., & Wagoner, B. L. (1978). Pupillometric signs of brain activation vary with level of cognitive processing. *Science*, *199*, 1216-1218.
- Bradley, M. T., & Janisse, M. P. (1979). Pupil size and lie detection: The effect of certainty on deception. *Psychology: A Quarterly Journal of Human Behavior*, *16*, 33-39.
- Bradley, M. T., & Janisse, M. P. (1981). Accuracy demonstrations, threat, and the detection of deception: Cardiovascular, electrodermal, and pupillary measures. *Psychophysiology*, *18*, 307-315.

- Capa, R. L., Audiffren, M., & Ragot, S. (2008). The effects of achievement motivation, task difficulty, and goal difficulty on physiological, behavioral, and subjective effort. *Psychophysiology*, *45*, 859-868.
- Cassidy, T. (2002). Problem-solving style, achievement motivation, psychological distress and response to a simulated emergency. *Counselling Psychology Quarterly*, *15*, 325-332.
- Cassidy, T., & Lynn, R. (1989). A multi-dimensional approach to achievement motivation: The development of a comprehensive measure. *Journal of Occupational Psychology*, *62*, 301-312.
- Cook, A. E., Hacker, D. J., Webb, A., Osher, D., Kristjansson, S., Woltz, D. J., et al., (2008). Lyin' eyes: Oculomotor measures of reading reveal deception. Manuscript in preparation.
- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*, 297-334.
- Crowne, D. P., & Marlowe, D. (1960). A new scale of social desirability independent of psychopathology. *Journal of Consulting Psychology*, *24*, 349-354.
- Crowne, D. P., & Marlowe, D. (1964). The approval motive: Studies in evaluative dependence. New York: John Wiley & Sons.
- DePaulo, B. M., Lanier, K., & Davis, T. (1983). Detecting the deceit of the motivated liar. *Journal of Personality and Social Psychology*, *45*, 1096-1103.
- DePaulo, B.M., Lindsay, J. J., Malone, B. E., Muhlenbruck, L., Charlton, K., & Cooper, H. (2003). Cues to deception. *Psychological Bulletin*, *129*, 74-118.
- Dionisio, D. P., Granholm, E., Hillix, W. A., & Perrine, W. F. (2001). Differentiation of deception using pupillary responses as an index of cognitive processing. *Psychophysiology*, *38*, 205-211.
- Ferreira, F., & Henderson, J. M. (1991). Recovery from misanalyses of garden-path sentences. *Journal of Memory and Language*, *30*, 725-745.
- Ferreira, F., & Henderson, J. M. (1993). Reading processes during syntactic analysis and reanalysis. *Canadian Journal of Experimental Psychology*, *47*, 247-275.
- Fukuda, K. (2001). Eye blinks: New indices for the detection of deception. *International Journal of Psychophysiology*, *40*, 239-245.
- Gailliot, M. T., Schmeichel, B. J., Baumeister, R. F. (2006). Self-regulatory processes defend against the threat of death: Effects of self-control depletion and trait self-

- control on thoughts and fears of dying. *Journal of Personality and Social Psychology*, *91*, 49-62.
- Gustafson, L. A., & Orne, M. T. (1963). Effects of heightened motivation on the detection of deception. *Journal of Applied Psychology*, *47*, 408-411.
- Heilveil, I. (1976). Deception and pupil size. *Journal of Clinical Psychology*, *32*, 675-676.
- Hess, E. H., & Polt, J. M. (1964). Pupil size in relation to mental activity during simple problem-solving. *Science*, *143*, 1190-1192.
- Honts, C. R., & Carlton, B. (1990). *The effects of incentives on the detection of deception: Report No. DoDPI90-R-0003*. Department of Defense Polygraph Institute, Fort McClellan, AL, DTIC# ADA305810.
- Hyona, J., Tommola, J., & Alaja, A-M. (1995). Pupil dilation as a measure of processing load in simultaneous interpretation and other language tasks. *The Quarterly Journal of Experimental Psychology*, *48A*, 598-612.
- Janisse, M. P., & Bradley, M. T. (1980). Deception, information, and the pupillary response. *Perceptual and Motor Skills*, *50*, 748-750.
- Johnson, R., Jr., Barnhardt, J., & Zhu, J. (2003). The deceptive response: Effects of response conflict and strategic monitoring on the late positive component and episodic memory-related brain activity. *Biological Psychology*, *64*, 217-253.
- Johnson, R., Jr., Barnhardt, J., & Zhu, J. (2004). The contribution of executive processes to deceptive responding. *Neuropsychologia*, *42*, 878-901.
- Johnson, R., Jr., Barnhardt, J., & Zhu, J. (2005). Differential effects of practice on the executive processes used for truthful and deceptive responses: An event-related brain potential study. *Cognitive Brain Research*, *24*, 386-404.
- Just, M. A., & Carpenter, P. A. (1993). The intensity of dimension of thought: Pupillometric indices of sentence processing. *Canadian Journal of Experimental Psychology*, *47*, 310-339.
- Kahneman, D., & Beatty, J. (1966). Pupil diameter and load on memory. *Science*, *154*, 1583-1585.
- Kane, M. J., & Engle, R. W. (2003). Working-memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *Journal of Experimental Psychology: General*, *132*, 47-70.
- Kircher, J. C., Horowitz, S. W., & Raskin, D. C. (1988). Meta-analysis of mock crime studies of the control question polygraph technique. *Law and Human Behavior*,

12, 79-90.

- Krapohl, D. J. (2002). The polygraph in personnel screening. In M. Kleiner (Ed.), *Handbook of polygraph testing* (pp. 217-236). San Diego, CA: Academic Press.
- Loewenfeld, I. E. (1999). *The pupil: Anatomy, physiology, and clinical applications* (Vol. 1). Boston: Butterworth-Heinemann.
- Lubow, R. E., & Fein, O. (1996). Pupillary size in response to a visual guilty knowledge test: New technique for the detection of deception. *Journal of Experimental Psychology: Applied*, 2, 164-177.
- Macleod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin*, 109, 163-203.
- Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin*, 126, 247-259.
- Muraven, M., Shmueli, D., & Burkley, E. (2006). Conserving self-control strength. *Journal of Personality and Social Psychology*, 91, 524-537.
- Muraven, M., & Slessareva, E. (2003). Mechanisms of self-control failure: Motivation and limited resources. *Personality and Social Psychology Bulletin*, 29, 894-906.
- Muraven, M., Tice, D. M., & Baumeister, R. F. (1998). Self-control as a limited resource: Regulatory depletion patterns. *Journal of Personality and Social Psychology*, 74, 774-789.
- National Research Council. (2003). *The polygraph and lie detection*. Committee to Review the Scientific Evidence on the Polygraph. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, 124, 372-422.
- Rayner, K., Chace, K. H., Slattery, T. J., & Ashby, J. (2006). Eye movements as reflections of comprehension processes in reading. *Scientific Studies of Reading*, 10, 241-255.
- Schluroff, M. (1982). Pupil responses to grammatical complexity of sentences. *Brain and Language*, 17, 133-145.
- Siegle, G. J., Ichikawa, N., & Steinhauer, S. (2008). Blink before you think: Blinks occur prior to and following cognitive load indexed by pupillary responses. *Psychophysiology*, 45, 679-687.

- Stern, J. A., Walrath, L. C., & Goldstein, R. (1984). The endogenous eyeblink. *Psychophysiology*, *21*, 22-33.
- Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643-662.
- Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality*, *72*, 271-324.
- Webb, A. K., Honts, C. R., Kircher, J. C., Bernhardt, P., Cook, A. E. (2008). *Effectiveness of pupil diameter in a probable-lie comparison question test for deception*. Manuscript submitted for publication.