IMPACT OF SELF-REPORTED BIASES AND FAMILIARITY IN A BAGGAGE SCREENING CONTEXT

THESIS

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Abstract

A common assumption is that items that evoke strong emotions are more easily recognized than items that do not evoke strong emotions (Bessette-Symons, 2008). For example, items such as guns or knives may evoke strong emotions within some people, and it may be presumed that these items may be more easily recognized by people that have strong emotions associated with them. If this is true, then perhaps these people would be more apt to locate these items in situations such as baggage screening services that rely on accurate detection of weapons for the public's safety. This study explores this reasoning to determine if emotional biases or familiarity impact the ability of subjects to detect guns or knives in a baggage screening scenario.

Subjects were administered a questionnaire to determine their degree of emotional bias and familiarity with guns or knives, and then were asked to detect guns or knives in a simulated baggage screening scenario. The results indicate that while increasing the sample size of the subject pool did not produce any significant effects on the number of weapon detections, adding more detailed emotional response questions seemed to produce a significant effect for positive emotion rather than negative emotion.

Dedication

For my lovely bride of 25 years, thank you for your continued patience during this trying time. Without your love and support this thesis would not have been possible.

Acknowledgments

There are many people to thank for their help in producing this thesis. My deepest appreciation goes to my advisor, Lt Col Langhals, for his most valuable direction and guidance during the development of this thesis. I truly appreciate his foundational work which allowed me to explore one of the interesting facets related to emotional bias and human behavior. I also thank the other members of my thesis committee, Col Schechtman and Dr. Heminger, for the many helpful suggestions and insights along the way as this product was taking shape. My sincere thanks go to Lt Col Elshaw and Capt Gilman, who helped advertise my need of experiment subjects to the AFIT students, and were instrumental in the abundant response of volunteers who participated in my experiments. All the people who participated in the experiments also deserve a great deal of thanks for their participation and flexibility as scheduling adjustments forced them to alter their plans, yet they did so with a gracious spirit.

My family, especially my bride of 25 years, has been wonderfully supportive of this endeavor and has been there to remind me to be “anxious for nothing” as the Bible explains in Philippians 4:6-7. My everlasting thanks goes to my Lord and Savior Jesus Christ who has orchestrated the events of my life and has directed the paths of the wonderful people that I have mentioned to intersect mine. My life and my time at AFIT have certainly been richer because our paths have crossed.

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IMPACT OF SELF-REPORTED BIASES AND FAMILIARITY IN A BAGGAGE SCREENING CONTEXT

I. Introduction

Background

The September 11, 2001 terrorist attacks have heightened the awareness of many Americans to the need of increasing our security posture on our public transportation systems. In particular, since commercial aircraft were the terrorists' vehicle of choice for employing their destruction, the airline industry became the focus of improved transportation security for many Americans. Attempted terrorist attacks involving the commercial airlines such as the 2001 Shoe Bomb Plot (Stark, 2001) and the 2009 Christmas Day Bombing Attempt (CBS, 2010) drew even more attention to the need for improving airline security. While these examples highlight the need for increased passenger screening, carry-on baggage screening and the allowable carry-on items are other areas that have come under increased scrutiny from the federal government (TSA, 2009).

After the September 11, 2001 attacks, the federal government created the Transportation Security Administration (TSA) to be responsible for securing the nation's commercial aviation system (Berrick, 2007). The TSA has been steadily improving the performance of their transportation security officers (TSOs) through rigorous training programs and by continuously improving their passenger checkpoint standard operating procedures at airports throughout the nation (Berrick, 2007). While weaknesses and vulnerabilities were noted in airports of all sizes immediately after 2001 (Berrick, 2005), TSA's national covert tests that were conducted between September 2005 and July 2006 continued to show some signs of weakness in the areas of passenger and baggage screening (Berrick, 2007).

The TSA uses sophisticated screening technologies such as walk-through metal detectors, X-ray machines, hand-held metal detectors, and explosive trace detectors to aid in the passenger and baggage screening process (Berrick, 2007). These technologies, coupled with improvements to the passenger checkpoint standard operating procedures (Berrick, 2007), work together to help increase airline security. Along with the technologies and procedures, visual search research may aid these standard operating procedures even more by offering improvements in visual search methods, and thus improving airline security. For example, the visual search research of Menneer et al (2007) suggests that using two people to examine X-ray images in a baggage screening scenario may be beneficial when both people are specialized on different subsets of the targets. For instance, a potential application of the Menneer et al (2007) research is that one person could be focused on searching for guns while the other person is focused on searching for knives. The Menneer et al (2007) research suggests that this method may produce increases in accuracy and speed for these baggage screening scenarios.

However, while this method may increase accuracy and speed for baggage screeners, using two people to perform this task may not be a practical solution if baggage screener staffing is limited at some airports. Perhaps a less labor-intensive method would be to apply key tenets of visual search theory to those factors which may influence a baggage screener's attention span, and thus increase each baggage screener's detection rate of hazardous items. Furthermore, if these factors that influence the baggage screener’s attention span can be discovered and duplicated, then training can be designed to incorporate these factors and reinforce them to baggage screening employees. These factors could also serve as a potential discriminator when selecting future baggage screeners from candidates competing for these positions.

Research Focus

While there could be many potential factors that may influence a baggage screener’s attention span, one of the factors may be the emotional interest that an observer places on an object. Recent literature explains that material which elicits an emotional response from a person is commonly assumed to be more accurately recognized than material which does not elicit an emotional response (Bessette-Symons, 2008). The extent of the baggage screener’s emotional interest in weapons such as guns or knives, which leads to emotional bias for weapons such as guns or knives, is one of the factors that this study examines. Another factor that may influence a baggage screener’s attention is related to how familiar an object is to the observer. That is, if there are multiple objects in a visual scene, attention can be biased in favor of the more familiar item in an involuntary manner (Soto et al., 2005).

This study will examine the emotional bias and familiarity factors of study participants concerning guns and knives, and will also track their ability to detect guns and knives in a baggage screening scenario. The purpose of the current study is to examine the impact of familiarity and emotional bias concerning guns and knives with the ability to detect these weapons in a baggage screening environment. This study uses data from a similar study performed by Langhals (2011), in which subjects were investigated using comparable criteria within a baggage screening environment.

Thesis Overview

This thesis is organized into several chapters that document the current study. Chapter two discusses current literature about familiarity, emotional bias, and applicable theories that are relevant to this study, and proposes the hypotheses related to weapon detection rates for baggage screeners. Chapter three discusses the experimental methods, subject demographics, and equipment that were used during the experiments for this study. Chapter four reviews the statistical analysis of the data that was gathered during the experiment, and relates this to the hypotheses to determine support or lack of support for the hypotheses. Chapter five reviews the results of this study, explains the significance of the results, notes the limitations of this study, and recommends areas for future research.

II. Literature Review

Chapter Overview

Commercial airline travel is a wonderful modern convenience, allowing passengers to transit hundreds of miles each day in a safe, cost-effective manner. One of the factors that contribute to the safety of not only the general public but also the Air Force personnel who use this mode of transportation each day is the careful inspection of the carry-on baggage by the Transportation Security Administration (TSA) employees. The TSA employees who inspect X-ray images of the contents of carry-on baggage are trained to recognize and detect unlawful or dangerous items, thus preventing them from boarding commercial aircraft which, of course, would be a threat to public safety. Obviously, the safety and well-being of the aircraft passengers and crew depend on the accurate recognition and detection capabilities of the baggage screeners, so anything that may impact their detection rates of dangerous items should be carefully examined such that their detection rates can be maximized as much as possible.

This study will explore how detection rates of dangerous items, such as weapons, can be impacted by the baggage screeners' emotional bias or familiarity of weapons such as guns and knives. Of particular importance to this study is to discover those emotional bias or familiarity conditions which either allows the baggage screeners to increase their detection rate of weapons, or prevents the baggage screeners from increasing their detection rate of weapons. As these optimal emotional bias or familiarity conditions are discovered, training scenarios could be developed that target current baggage screeners so they could be aware of the appropriate emotional bias and familiarity factors that will maximize their detection rates. However, it may prove difficult to design a training scenario to change a person's long-held emotional bias towards guns or knives. Yet, this type of knowledge would be useful as an aptitude test when hiring prospective baggage screeners so that those with the appropriate emotional bias and familiarity concerning weapons could be placed in commensurate positions. The safety of the public may depend on how this knowledge is used for the benefit of new and existing baggage screeners, because a resulting increase in the detection rate of weapons for the baggage screeners will result in fewer weapons that will board a commercial aircraft, which will lead to a corresponding increase in the safety of the airline passengers and crew members.

In addition to this relationship with familiarity and detection rates, extant literature also points out that the observer's emotional interest of an object, which leads to bias towards an object, is related to the attention of the observer. The attention of the observer, in turn, will influence the observer's detection rate (Mathews et al., 1997). Again, this scenario can be applied to the emotional bias that a baggage screener would have for a weapon such as a gun or knife when searching for these items in an X-ray image of a suitcase. The more emotional bias that baggage screeners have for guns or knives may impact their attention, and therefore, their detection rate of the weapons as they perform their screening duties. In order to improve the baggage screeners' weapon detection rates, two interesting characteristics to consider would be their familiarity with weapons, and their emotional bias concerning weapons.

Recent literature points out that in the competition between multiple objects in a visual scene, attention can be biased in favor of the more familiar item in an involuntary manner (Soto et al., 2005). This type of situation can be easily applied to a baggage screener who is searching an X-ray image for dangerous items such as guns or knives among other typical items which would be found in a suitcase or other carry-on bag. That is, if a baggage screener is very familiar with the appearance of guns or knives, then this familiarity could positively impact or bias their detection rate towards identification of guns or knives within luggage items. At the same time, this also implies that a baggage screener who exhibits a lack of familiarity for guns or knives may exhibit a negative detection bias towards the identification of these weapons.

This chapter reviews the current literature concerning emotional bias as well as familiarity and each of their respective impacts on object recognition within a baggage screening context. Hypotheses are proposed based upon the results of the literature review and, in a later chapter, these hypotheses are tested against the data collected as a result of the experiments and questionnaires. The specific research questions that this study proposes to investigate are:

1. Does a self-reported emotional bias impact the subject's ability to detect items such as guns or knives that should not be allowed on an aircraft?

2. Does familiarity with guns or knives impact the subject's ability to detect items such as guns or knives that should not be allowed on an aircraft?

Impact of Emotional Bias

The TSA baggage screeners, like many other people, may or may not be consciously aware of their emotional biases (Banaji et al., 2003), or they may not be willing to admit that they have any biases at all (Unkelbach et al., 2008). Likewise, the employers or managers of the baggage screeners may not recognize the extent of these unconscious biases in their employees (Banaji et al., 2003). Certainly, if managers cannot recognize these biases then they could do very little to control them. However, if the baggage screeners' emotional bias of weapons can be detected, measured and compared with the baggage screeners' weapon detection rates, then perhaps some relationship between emotional bias and weapon detection rate may be discovered which optimizes the weapon detection rate for baggage screeners.

In a study involving recognition accuracy and response bias for emotional words and pictures, the results showed that subjects felt a negative emotional reaction to some pictures when, in fact, the pictures should have provoked neutral emotional reactions in the subjects, not negative emotional reactions (Bessette-Symons, 2008). The study also suggested that there is an enhancement in memory accuracy for pictures which produced negative emotional reactions in subjects, and that these pictures which produced negative reactions also seemed to be remembered better than pictures which produced neutral emotional reactions in subjects (Bessette-Symons, 2008). Other researchers have come to similar conclusions. For instance, in their study of the emotional stimuli of pictures, Tapia et al (2008) note that there is evidence of a bias to respond to pictures which result in negative emotional responses as opposed to positive emotional responses in memory studies. Also, Öhman et al (2001) point out in their study of responses to pictures containing fear-relevant objects that participants were consistently faster to find a fear-relevant stimulus than a fear-irrelevant stimulus. Their findings suggest that humans are more likely to direct their attention to pictures of potentially threatening animals than pictures of non-threatening animals (Öhman et al., 2001). In another study which assessed subjects' recognition of stimuli which produced positive and negative emotional responses, the results indicated that stimuli which produced positive emotional responses were recognized at a lower rate than stimuli which produced negative emotional responses (Robinson-Riegler, 1996), further supporting the bias humans have towards recognizing stimuli which produce negative emotional responses. Diverse literatures in psychology provide evidence that, other things being equal, stimuli which produce negative emotional responses appear to elicit more physiological, affective, cognitive, and behavioral activity and prompt more cognitive analysis than stimuli which produce neutral or positive emotional responses (Taylor, 1991).

This bias towards pictures or stimuli that produce negative emotional responses can possibly be explained as an adaptive strategy or function for the survival of the individual, in that the consequences of not recalling an aversive or negative situation can be far more dangerous than the consequences of not recalling a positive experience (Tapia et al., 2008). Similarly, another study suggests that emotional systems could have developed to help humans allocate their limited attentional resources to appropriately handle threats and opportunities in the world (Bradley et al., 2007). Since humans can pay attention to only a small amount of information at any one time in a visual scene (Duncan and Humphreys, 1989), and if this information is critical to an individual's survival, then it is imperative that a person's attention should be prioritized to that which is most important for continued survival. This argument is echoed by Baumeister et al (2001) as they point out that since survival requires urgent attention to any possibly bad outcomes, it would be adaptive to be psychologically designed to respond to danger or the possibility of a bad outcome more strongly than a good outcome. Indeed, a person who ignores the possibility of a good outcome may experience regret at having missed an opportunity for pleasure, but a person who ignores danger may end up maimed or dead (Taylor, 1991; Baumeister et al., 2001).

An opposing viewpoint to this bias for processing information that elicits negative emotional responses is the "Pollyanna Principle" which states that people process information that elicits positive emotional responses more accurately and efficiently than information that elicits less pleasant emotional responses, and that people recognize stimuli that produce a pleasant emotional response faster than stimuli that produce an unpleasant emotional response (Matlin and Gawron, 1979; Bessette-Symons, 2008). However, in the Baumeister et al. (2001) study which proposes that bad events are stronger than good, they refute the Pollyanna Principle by suggesting that the preference for information which provokes a positive emotional response makes the greater power of information which provokes a negative emotional response especially remarkable because it must overcome the positive bias of the Pollyanna Principle. Their view is that the greater frequency of good is the natural complement to the greater power of bad, or that good can only match or overcome bad by strength of numbers (Baumeister et al., 2001). Furthermore, the Pollyanna Principle has found little support elsewhere. The Robinson-Riegler study mentioned earlier found no support for the Pollyanna Principle, as participants were better at correctly rejecting items that produced a negative emotional response than items that produced a positive emotional response (Robinson-Riegler, 1996).

Relating the ideas from the review of the emotional bias literature to the baggage screening scenario is rather straightforward. Baggage screeners who have an emotional bias toward objects which elicit negative emotional responses, such as those of guns or knives, should have an increased detection rate when they are searching for guns or knives. This can be due to the innate "survival" function which considers the consequences of not finding these weapons in carry-on baggage, even though baggage screeners may review an abundance of other non-threatening items during their shifts.

Additionally, some of these non-threatening, distracting items may produce evidence that results in a false alarm (Palmer et al., 2000). These distracting items, coupled with an emotional bias toward objects which elicit negative emotional responses, could induce a higher false positive detection rate among baggage screeners. This, in turn, may add an operational and training challenge for those assigned to monitor baggage screener detection rates.

Impact of Familiarity

Familiarity, for the purposes of this study, is defined as the degree to which a person comes in contact or thinks about a given object or concept (Snodgrass and Vanderwart, 1980). This implies that a person does not necessarily need day-to-day contact with an object to be familiar with it, but rather that a person could have occasional thoughts or interest in an object to be familiar with it. In the study of a visual attention model for fast object recognition, Lee et al (2010) point out that various psychological experiments have shown that human vision exhibits an attentional bias towards familiar objects. This implies that familiar objects should be detected at a greater rate than unfamiliar objects. This idea is further supported in the area of speeded test conditions, much like those found in a baggage screening context. In a review of 30 years of research on familiarity models and methods, Yonelinas (2002) reports that under speeded test conditions subjects are found to be able to make accurate discriminations that can be based on familiarity. Also, familiarity was found to be a fast, signal-detection-like process which reflects the quicker, quantitative memory strength information and supports a wide range of recognition confidence responses (Yonelinas, 2002).

However, a note of caution may be in order regarding familiarity with the *task* of the baggage screeners. In a study on familiarity in proofreading tasks, research indicates that as subjects became increasingly familiar with the proofreading task, the subjects' tendency to find proofreading errors decreased with increasing the time spent on the same task, which could be explained in the context of vigilance studies in which subjects became increasingly more conservative about producing detection responses with time spent on the task (Goolkasian, 1985). Therefore, Goolkasian (1985) recommends that one should undertake repetitious tasks for short periods of time in order to reduce the occurrence of errors. Certainly, this caution would be applicable for baggage screeners so that they should be encouraged to take frequent breaks when possible and reduce the possibility of not detecting guns and knives in X-ray images.

One additional concern is the presence of distracting items that are mistaken for familiar items may produce a false alarm (Palmer et al., 2000). These distracting items that appear to be familiar items could induce a higher false positive detection rate among baggage screeners. This may contribute to operational and training challenges for those assigned to monitor baggage screener detection rates.

Impact of Interactions between Emotional Bias and Familiarity

The available literature concerning the impact of the interactions between emotional bias and familiarity as they impact detection rates is quite limited. However, some studies provide some insight on how these interactions may impact detection rates. For instance, the Caharel et al (2005) study noted that the neural and behavioral responses of subjects to levels of familiarity and emotional expression of faces were observable, but did not interact. In other words, the results of the experiment indicated that the familiarity of a face to a subject and the emotional expression represented by that face to a subject operated by means of two independent processing activities (Caharel et al., 2005). Incidentally, these results support the same contention of parallel and independent processing of familiarity and emotional expression as proposed by Bruce and Young (1986). However, the emotional expression interpreted by an experimental subject is not equivalent to the emotional bias experienced by the experimental subject. While this discrepancy is noted, these studies (Caharel et al., 2005; Bruce and Young, 1986) indicate that familiarity and emotional responses operate on independent planes, without interactions between them. Recognizing that emotional bias is one form of an emotional response, one can assume that familiarity and emotional bias could also operate on independent planes, without interactions between them. This aids the current study in that it sets expectations concerning the interactions between emotional bias and familiarity with regard to the detection rate of weapons. That is, the interactions of these two factors upon the detection rate of weapons should be minimal, if at all.

Additionally, the extant literature does not provide much indication whether familiarity or emotional bias would have a greater impact on detection rates. Yonelinas

(2002) does indicate that familiarity is a faster, relatively automatic process when compared to the recollection process. Given that familiarity is a quicker, quantitative response when compared to the qualitative response of recollection (Yonelinas, 2002), one could argue that familiarity, due to its quicker response, may have more of an impact on detection rates than the slower, more qualitative response that may be associated with emotional bias. While this point is beyond the scope of the present study and is not expected to impact this study in any fundamental way, this may be an area to investigate for future research but will not be explored any further during this study.

Feature-Integration Theory of Attention

One of the theories that apply to this study is the Feature-Integration Theory of Attention, introduced by Treisman and Gelade (1980). This theory proposes that focused attention must be directed serially to each stimulus in a display whenever conjunctions of more than one separable feature are needed to characterize or distinguish the possible objects presented. For instance, searching for a face, even as familiar as one's own child, in a school photograph, can be a painstakingly serial process, and so focused attention is certainly recommended in proof reading, instrument monitoring (Treisman and Gelade, 1980), or in a serial process such as baggage screening. According to Duncan (1989), people can only pay attention at any one time to only a small amount of the information present in a visual scene. Therefore, baggage screeners must focus attention on each object in an X-ray to effectively detect weapons. The accuracy of detection may be impacted by the presence of distracters or items that appear similar to weapons but in fact are innocuous household items (Treisman and Gelade, 1980). The Feature-Integration

Theory impacts the current study because it explains that subjects can more effectively detect objects by devoting their serial attention span to those features in the display that have similar characteristics to the items for which they are searching. For instance, a baggage screener searching for a gun or knife would search for objects that have the length of a knife blade or gun barrel, instead of round objects such as a button. Also, this Theory implies that baggage screeners may employ search efficiency methods such as reviewing X-ray pictures from side-to-side or in a circular motion to more efficiently ration their attention to objects. In addition to this, if the baggage screener has an emotional bias or is familiar with guns or knives, the serial nature of the visual search would allow the biases to activate more quickly. That is, if baggage screeners have an emotional bias or are familiar with guns or knives, then feature integration may allow them to more quickly recognize the object which is familiar or has more emotional bias than other items.

Signal Detection Theory

Another theory applicable to this study is the Signal Detection Theory (SDT), which is used to analyze data coming from experiments in which the task is to categorize ambiguous stimuli which can be generated either by a known process (called the "signal") or be obtained by chance (called the "noise"). This theory was originally proposed by Green and Swets (1966) to study the responses of radar operators as they detected an aircraft (the signal) or the presence of background disturbance (the noise) (Abdi, 2007). In a baggage screening scenario in which TSA employees are searching for weapons, the "signal" would correspond to a gun or knife that is detected in an X-ray image of carry-on luggage. The “noise” in this Signal Detection Theory framework would correspond to any item besides a gun or a knife which would also appear in an X-ray image of carry-on luggage. Signal Detection Theory posits that an observer responds “yes” or “no” regarding the presence of a signal during each trial of the experiment. Correctly indicating the presence of a signal is called a “hit”, and correctly indicating the absence of a signal is called a “correct rejection”. Furthermore, indicating that a signal is present when it is absent is called a “false alarm”, and indicating that a signal is absent when it is actually present is called a “miss” (Lerman et al., 2010). According to the Signal Detection Theory, the four possible responses of the baggage screener’s detection of a weapon are organized in Table 1.

Table 1: The Four Possible Types of Responses in SDT (Abdi, 2007)

	BAGGAGE SCREENER’S RESPONSE	
REALITY	**Weapon Detected**	**Weapon Not Detected**
Weapon Present	Hit	Miss
Weapon Absent	False Alarm	Correct Rejection

Observe, Orient, Decide and Act (OODA) Loop Concept

Interestingly, the OODA Loop Concept (Rahman, 2010) can be applied to this study. The OODA Loop was first described by Col John Boyd in an effort to describe the process used by pilots to conduct combat flying operations. In OODA Loop terms, “observe” refers to the collection of data by means of the senses, “orient” refers to the analysis of the data to form a mental perspective, “decide” refers to the determination of a course of action, and “action” refers to the implementation of a course of action (Rahman, 2010). With this overall view of the OODA Loop, one can make a logical correlation from it to both the Feature-Integration Theory of Attention and the Signal

Detection Theory. For example, the "observe" and "orient" phases of the OODA Loop strongly correlate to the idea of the focused attention (observe) which must be directed to each stimulus in a display, and the intentional search process (orient) found within the Feature-Integration Theory of Attention (Treisman and Gelade, 1980). In a similar manner, the "decide" and "action" phases of the OODA Loop strongly correlate to the idea of deciding that a signal is present and distinguishable from noise (decide), and responding to the presence of the signal by means of the appropriate action (action), as described in the Signal Detection Theory (Green and Swets, 1966). Relating these ideas to the baggage screening scenario, the baggage screener must focus attention at objects in the X-ray picture (observe), search for the weapon (orient), determine if a weapon is present (decide) and take the appropriate action (act).

Hypothesis Generation

As presented earlier, several studies have demonstrated that subjects who have a negative emotional bias towards objects which provoke negative emotional responses result in a greater detection response than subjects who have neutral or positive emotional biases towards these objects (Bessette-Symons, 2008; Tapia et al., 2008; Öhman et al., 2001; Robinson-Riegler, 1996; Bradley et al., 2007; Baumeister, 2001; Taylor, 1991). Therefore, the following hypothesis is offered regarding the impact of emotional bias on a subject's detection response:

> *H1: Subjects who have a negative emotional bias against guns or knives will have a greater detection response than subjects who have a non-negative bias against them.*

Extant literature supports the concept that human vision exhibits a bias towards familiar objects (Lee et al., 2010), so familiar objects should be detected at a higher rate than unfamiliar objects. Also, under speeded test conditions, such as those found in baggage screener duties, subjects are found to be able to make accurate discriminations that can be based on familiarity (Yonelinas, 2002). Therefore, the following hypothesis is offered regarding the impact of familiarity on a subject's detection response:

H2: Subjects who are familiar with guns or knives will have a greater detection response than subjects who are not familiar with them.

Finally, the literature is limited regarding the interactions of familiarity and emotional bias and its impact upon detection response rate, but the available literature does support the concept that familiarity and emotional processing are independent of one another, without interactions between them (Caharel et al., 2005; Bruce and Young, 1986). Therefore, the following hypothesis is offered regarding the impact of the interactions of familiarity and emotional bias on a subject's detection response:

H3: The familiarity and emotional bias factors are independent of one another.

Expected Results

The results for the detection response bias can be easily displayed by means of the graphical method found within Hodos (1970), which is designed for detection experiments. Referring to Figure 1, a point on the y axis (at the left of the square) represents bias to report the absence of the signal, meaning that the subject had a conservative response bias. Likewise, a point on the x axis (at the top of the square) represents bias to report the presence of a signal, indicating the subject had a liberal response bias (Hodos, 1970). The formulas within the unit square represent the percentage of response bias calculations for the points falling within the displayed sections of each graph.

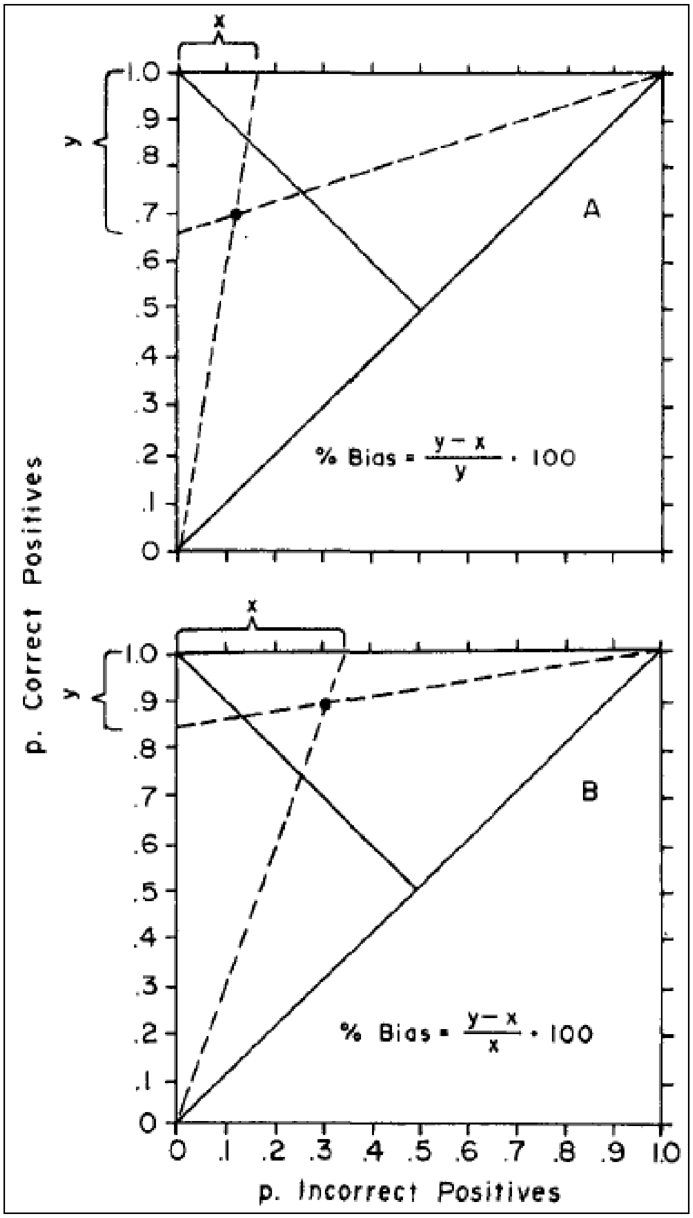

Figure 1: Method of Determining Percentage Bias (Hodos, 1970)

According to hypothesis H1, those subjects who have a negative emotional bias against guns or knives should have a more liberal response bias when asked to detect these weapons in a baggage screening context. Therefore, according to Hodos (1970), those subjects who have a liberal response bias should have a response bias in the negative quadrant of the graph as shown by the red arrow in Figure 2. Likewise, according to hypothesis H2, those subjects who are familiar with guns or knives should have a more liberal response bias when asked to detect these weapons in a baggage screening context. Again, according to Hodos (1970), those subjects who have a liberal response bias should have a response bias in the negative quadrant of the graph as shown by the red arrow in Figure 2. Conversely, it is expected that those subjects who have either a non-negative bias with guns or knives or who are not familiar with guns or knives should have a more conservative response bias, and according to Hodos (1970), should have a response bias in the positive quadrant of the graph as shown by the green arrow in Figure 2.

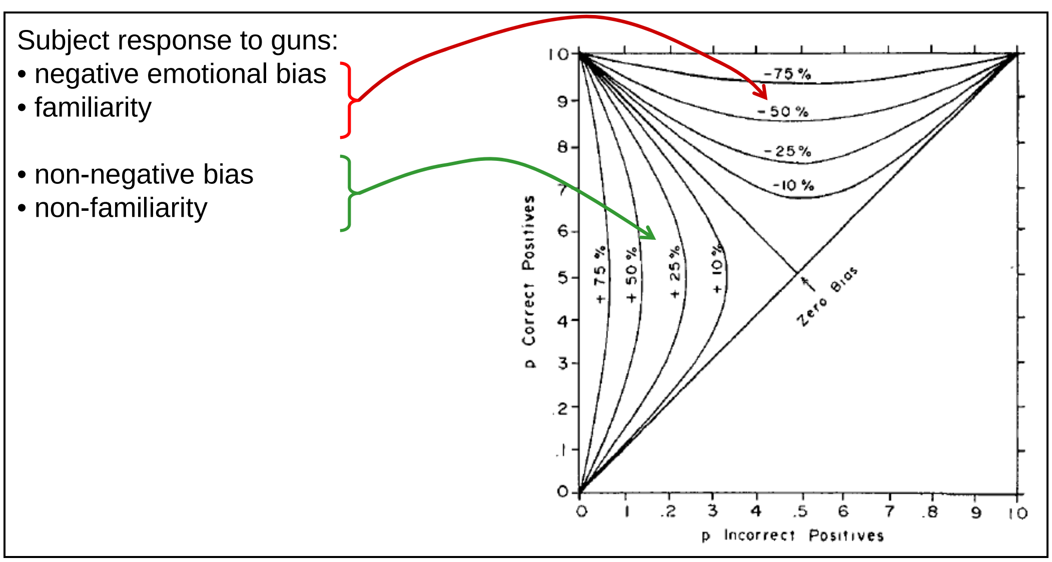

Figure 2: Two Families of Isobias Contours (Hodos, 1970)

Finally, hypothesis H3 can be tested by using SPSS to perform a 2 X 2 ANOVA on the familiarity and emotional bias factors, and studying the interaction effects of familiarity and emotional bias.

The Hodos (1970) graph in Figure 2 implies that false alarms will be occurring to some degree in a signal detection experiment. Although the extant literature did not have much to offer regarding any predictions concerning familiarity and emotional response with false alarms, the structure of the graph in Figure 2 implies that false alarms, or incorrect positives, will more frequently occur in the quadrant with the negative bias scores. Since this is the same quadrant in which those subjects who would have a negative emotional bias or familiarity with guns would occur, it is expected that these same subjects would incur a greater number of false alarms than those with other response biases.

III. Methodology

This chapter describes the methods and procedures used in this study to conduct research on the influence of self reported biases against guns or knives and familiarity with guns or knives on the ability to detect guns or knives in a baggage screening situation. This chapter also describes the subject population and equipment used to conduct the experiments. Finally, the design of the experiment, data gathering methods and analysis techniques are reviewed.

Overall Method

As a follow-on study to a portion of Langhals (2011), this study measured how accurately subjects detected the presence of guns or knives among non-threatening items in the context of an airport baggage screening situation. Of particular interest to this study was to determine the subjects' emotional biases concerning guns and knives as well as their familiarity with these items, and how these factors impacted the subjects' detection abilities. To measure these factors for each subject, a questionnaire was administered to the subjects which contained relevant items from the Langhals (2011) study as well as additional questions that were designed to provide additional detail to the familiarity and emotional bias factors that were found in the Langhals (2011) study. The questionnaire which was administered to the subjects for this study is at Appendix B.

After the subject completed the questionnaire, the subject was given about five minutes of training concerning the equipment used in the experiment, which consisted of a laptop computer with a mouse for detecting weapons in the simulated X-ray pictures.

After this training, the subject was asked to spend approximately 40 minutes reviewing simulated X-ray pictures of carry-on baggage to detect weapons such as guns or knives from among other typical carry-on baggage items. The detection equipment in this experiment recorded the responses of the subject to each picture that was displayed. Referring to Table 1, the four possible responses of the subject to the presence or absence of a weapon were:

- a weapon was detected when it was present (Hit)
- a weapon was not detected when it was present (Miss)
- a weapon was detected when it was absent (False Alarm)
- a weapon was not detected when it was absent (Correct Rejection)

The response for each set of subjects from the Langhals (2011) study and the current study was displayed according to the graphical method outlined in Hodos (1970), which illustrated whether the subjects responded conservatively or liberally to the stimulus when it was presented.

The data from the questionnaires and the data from the results of the detection experiments were analyzed to investigate the relationships of the subjects' familiarity and emotional attachment with guns or knives to the subjects' ability to detect these items among a group of innocuous items. As mentioned earlier, the data from this study was combined with the data from the Langhals (2011) study to determine the support or lack of support for Hypotheses 1, 2 and 3 (H1, H2 and H3). The relationship of the subjects' familiarity and emotional bias towards guns or knives and the impact upon their detection ability was not explored in the Langhals (2011) study.

Subjects for Study

The subjects for this study were recruited primarily from the student body of the Air Force Institute of Technology (AFIT) School of Engineering and Management. Other subjects were friends, social acquaintances and former co-workers of the research team, and were mainly U.S. citizens. Table 2 displays the demographics of the experiment subjects.

Table 2: Subject Demographics (Langhals, 2011)

	N	Age			Ethnicity				
		Min	Max	Mean	White	Black	Hispanic	Asian	Other
Male	30	23	64	35.1	26	1	2	1	0
Female	3	22	64	37.3	2	0	1	0	0
Total	33	22	64	35.3	28	1	3	1	0

Instruments

The instruments used to conduct this study included a pre-experiment questionnaire, a laptop computer, and a computer program. These items were used to gather data, display the simulated X-rays, and record the responses of the subjects. The following sections describe the purpose and use of each of these instruments.

Questionnaire

The study questionnaire was used to capture each subject's emotional bias and familiarity factors before the detection experiment began. The questionnaire was also used to capture each subject's demographic information such as age and ethnicity. This questionnaire was based largely upon the Langhals (2011) study in order to facilitate the combination of data sets between the current study and the Langhals (2011) study. Additional questions were added to the questionnaire which was designed to further explore the emotional bias and familiarity factors found in Langhals (2011). The study questionnaire can be found at Appendix B.

Hardware

A single laptop computer was used to interface the subject with the software which controlled the display and timing of the X-ray pictures. The computer also tracked the responses of the subjects as they viewed the simulated X-rays and recorded those responses into a local data file for later analysis. Each subject used the same laptop computer configuration to limit the variance in the subject's experience with the experiment.

Software

The software application which controlled the display and timing of the simulated X-rays for this experiment is called "Presentation", a software package created by Neurobehavioral Systems, Inc. Presentation is a stimulus delivery and experimental control program, and was the same software that was used in the Langhals (2011) study. For the purposes of this study, Presentation was programmed to present the simulated X-rays to the subjects, control the timing of the x-rays, and also maintained a log file of each subject's correct and incorrect detection of banned items (Langhals, 2011). The Presentation software used preset configuration parameters as well as some simple coding to present the simulated X-ray pictures to the subject at the required times. Appendix C contains screen shots of the Presentation software configuration that was required to conduct this study. Also, Appendix D contains the coding required for the software to function as needed for the experiment.

Microsoft Excel was used to store and organize the responses of the subjects to the questionnaire. Excel was also used to format the questionnaire data which was uploaded into the statistical analysis software package. For the statistical analysis of the questionnaire and detection response data for the experiment, SPSS 16.0 was used to provide the ANOVA and descriptive statistics found in this paper.

Data Collection

Each subject completed a questionnaire which contained two familiarity questions and two emotional response questions which were identical to the Langhals (2011) study, and an additional two familiarity and two emotional response questions which were not in the Langhals (2011) study. The additional questions were designed to further probe the subject's familiarity and emotional response towards guns and knives, beyond those questions found in the Langhals (2011) study. The additional emotional response questions were patterned after the Positive and Negative Affect Schedule (PANAS) which was developed by Watson et al (1988) as a measurement of a subject's emotional state or mood. The advantage of using the PANAS scale to measure the subject's emotional response is that these two sets of positive and negative scales are internally consistent and have excellent convergent and discriminant correlations with lengthier measures of the underlying mood factors (Watson et al, 1988). These items from the PANAS scale were used to measure the subject's feelings concerning guns and knives, which is an additional measurement that Langhals (2011) did not provide. Each subject responded to the questionnaire by circling the appropriate number on a five-point Likert scale which corresponded to their degree of agreement or disagreement with the familiarity or emotional response statement.

To determine support or lack of support for the hypotheses it was important to capture both positive and negative degrees of familiarity and emotional response. The study participants responded to statements which measured these various degrees by selecting corresponding numbers from a five point Likert scale. The selection numbers on the Likert scale ranged from a low of one, indicating disagreement with a statement, to a high of five, indicating agreement with a statement. If the number three on the Likert scale was selected, this indicated that the subject neither agreed nor disagreed with the statement. To capture the positive and negative degrees of familiarity and emotional response for each statement, a conversion process on the five point Likert scale was implemented to determine the score for each statement. These scores corresponded to low and high degrees of familiarity and emotional response, with zero corresponding to a "neither agree nor disagree" response. This conversion process, illustrated in Table 3, resulted in a range of scores for each question that was from a low of negative two to a high of positive two.

Table 3: Scoring Method for Subject Responses

I have personally fired a gun in the past					
	Disagree				**Agree**
Subject Response	1	2	3	4	5
Familiarity Rating	Unfamiliar	Unfamiliar	Neutral	Familiar	Familiar
Numerical Rating	-2	-1	0	1	2

The subject response according to the five point Likert scale from each questionnaire was entered into an Excel spreadsheet, the subject response was converted to a numerical rating (per Table 3), and scores for the familiarity and emotional response questions were calculated for each subject by adding the scores for the two familiarity questions together which resulted in a final familiarity score. Likewise, the scores for the emotional response questions were added together which resulted in a final emotional response score. In order to group the scores into low and high components for use within SPSS, the scores were classified into low and high familiarity and low and high emotional response rankings such that scores which totaled zero or less were assigned a classification equal to one, and scores which totaled greater than zero were assigned a classification equal to two.

Besides completing the questionnaire, each subject also participated in the detection experiment in which a gun or knife appeared in random slides which simulated an X-ray picture of carry-on baggage. When the subject believed that a gun or knife appeared in the slide, the subject pressed the computer mouse button and the Presentation software recorded the corresponding slide number in a log file. After the experiment was completed for each subject, the slide numbers that the Presentation software recorded in the log file were compared to the answer key in order to determine the hits, misses, and false alarms for each subject. Further examination of this raw data revealed areas in which the subject pressed the mouse button after the software had advanced past the slide containing the weapon, which recorded a "miss" for the slide containing the weapon and a "false alarm" for the next slide which did not usually contain a weapon. In this situation the subject was allowed the "late click" and was credited with detecting the weapon while not penalized for the false alarm on the subsequent slide. This data correction was consistent with the same correction employed during the Langhals (2011) study. The corrected data for each subject was entered into the same Excel spreadsheet which contained each subject's questionnaire response so that the data set could be loaded into SPSS for statistical analysis.

Experimental Design

Because the data gathered during these experiments was combined with the data found in Langhals (2011), it was necessary to reproduce the Langhals (2011) experimental setup and procedure as much as possible in the current study. Therefore, the same type of display and controlling software (Presentation) was used as well as the same simulated X-ray pictures as was reported in Langhals (2011). Furthermore, the Presentation software was configured in the same manner such that each subject would view each simulated X-ray picture for four seconds before advancing on to the next simulated X-ray picture. The subject was required to detect the presence of a weapon within this four second interval. If the subject did not respond within this four second interval, this was considered a "miss" for the subject. Each subject was required to review a total of 600 simulated X-ray pictures in a time span of 40 minutes, as in the Langhals (2011) study.

The 600 simulated X-ray pictures were created using Microsoft PowerPoint, and were black and white collages of common items that people are allowed to bring on board an aircraft. Each of the X-ray pictures consisted of between 14 to 26 black and white images of various sizes and orientations, to represent the random placement of carry-on items in a typical piece of luggage. Figure 3 shows a simulated X-ray picture which contains one of the weapons which the subjects were asked to detect.

Figure 3: Simulated X-ray Picture with Weapon (Langhals, 2011)

The participants were exposed to approximately five minutes of training on the operation of the computer equipment as well as discerning the banned from permissible items in the simulated X-ray pictures. Approximately 17 slides were used to train the subjects during this orientation session.

Of the 600 simulated X-ray pictures which were used for each subject, a total of 32 simulated X-rays (5.3%) contained one banned item. The 32 simulated X-ray pictures that contained weapons were randomly assigned to occur among the total number of pictures in the experiment. In addition, the response of the subject had no impact on the frequency of appearance of the simulated X-ray pictures which contained a weapon. The Presentation software only allowed the pictures which contained the weapons to occur at specific times and intervals, which could not be changed or controlled by the subject (Langhals, 2011).

Design Considerations

In order to provide subjects a minimal level of proficiency in detecting guns and knives in the simulated X-ray pictures, the subjects were provided with approximately five minutes of training to familiarize them with the pictures of the weapons. This training also provided an opportunity for the subjects to operate the computer equipment used to detect the weapons. The same computer equipment was used throughout the experiment for each subject, which minimized the equipment variability from subject to subject.

Hypothesis Measures

During the experiment the subject was instructed to press the computer mouse button only when a weapon was detected. When the mouse button was pressed the Presentation software recorded the corresponding slide number in a log file. This number would either correspond to a hit (if the weapon was present) or a false alarm (if the weapon was not present). The numbers that the Presentation software recorded in the log file were compared to the answer key in order to determine the hits, misses, and false alarms. In addition, the study questionnaire recorded each subject’s emotional bias and familiarity with guns and knives as well as demographic information. These measures provided the data required to determine support or lack of support for the study hypotheses. The hypothesis measures are summarized in Table 4. The measures are based upon either the self-report questionnaire or the data recorded by the Presentation software.

Table 4: Hypothesis Measures (Langhals, 2011)

Hypothesis	Measure(s)
Hypothesis 1: Subjects who have a negative emotional bias against guns or knives will have a greater detection response than subjects who have a non-negative bias against them.	Comparison of correct detection of banned items as recorded by Presentation software between those subjects who reported negative and non-negative biases against them
Hypothesis 2: Subjects who are familiar with guns or knives will have a greater detection response than subjects who are not familiar with them.	Comparison of correct detection of banned items as recorded by Presentation software between those subjects who reported familiarity and non-familiarity with them
Hypothesis 3: The familiarity and emotional bias factors are independent of one another.	Comparison of correct detection of banned items as recorded by Presentation software among all subjects

The experiment described in this chapter was designed to test the impacts of emotional biases against guns or knives and familiarity with guns or knives on the ability to detect guns or knives in a baggage screening situation. This chapter also described the subject population and the equipment used to conduct the experiments. Chapter four will review the data analysis of the experiment results and will discuss the support or non-support of each hypothesis.

IV. Analysis and Results

Chapter Overview

This chapter describes how the data collected from the present study was combined with the data from Langhals (2011), and it also reviews the statistical analysis of this combined data. This chapter also examines additional data from the subjects in the present study which resulted from additional questions regarding familiarity and emotional reactions regarding guns and knives. It examines the impacts of emotional bias and familiarity concerning guns and knives to a subject's ability to detect these weapons in a baggage screening scenario. The findings of the statistical analysis are related to the hypotheses which were generated in chapter two to determine support or lack of support for these hypotheses.

Combining Data Sets and Analysis

As mentioned previously, the data from the present study which consisted of the detection experiment results and the responses to the questionnaires was combined with the same data from a similar study performed by Langhals (2011) which used students from the University of Arizona as subjects. The demographics of the student subjects from the Langhals (2011) study which were used in this study are shown in Table 5.

Table 5: Subject Demographics for Langhals (2011) Study

	N	Age			Ethnicity				
		Min	Max	Mean	White	Black	Hispanic	Asian	Other
Male	29	20	33	22.5	13	1	3	10	2
Female	12	19	40	22.2	7	1	2	1	1
Total	41	19	40	22.4	20	2	5	11	3

Combining the demographics of the students in the Langhals (2011) study with the AFIT subjects of the present study in Table 2 yields the combined demographics chart in Table 6.

Table 6: Combined Demographics for Langhals (2011) and AFIT Studies

	N	Age			Ethnicity				
		Min	Max	Mean	White	Black	Hispanic	Asian	Other
Male	59	20	64	28.9	39	2	5	11	2
Female	15	19	64	25.2	9	1	3	1	1
Total	74	19	64	28.1	48	3	8	12	3

As explained earlier, the subject responses from the familiarity and emotional response questions were scored and grouped into low and high familiarity and emotional response classifications to facilitate data analysis within SPSS.

After the data was loaded into SPSS for this combined data set, a 2 X 2 ANOVA was performed to evaluate the effects of familiarity and emotional response on "hits" and "false alarms" of weapon detection responses. For the hits of the weapon detection responses the ANOVA indicated no significant main effects for familiarity, $F(1,70) = .18$, $p = .67$, or emotional response, $F(1,70) = .39$, $p = .53$, nor were there any significant interactions between familiarity and emotional response, $F(1,70) = .41$, $p = .52$. For the false alarms of the weapon detection responses the ANOVA indicated no significant main effects for familiarity, $F(1,70) = .04$, $p = .85$, or emotional response, $F(1,70) = .02$, $p = .88$, nor were there any significant interactions between familiarity and emotional response, $F(1,70) = 1.12$, $p = .29$. Thus, examining the combined data set with the same familiarity and emotional response questions yielded no significant results.

Adding Familiarity and Emotional Questions and Analysis

As mentioned previously, two familiarity and two emotional response questions were added to the questionnaire for the AFIT subjects in the current study so that the familiarity and emotional response of the subjects could be measured in greater detail than with the Langhals (2011) study. The emotional response of the AFIT subjects was further probed with the use of the PANAS scale which was developed by Watson et al (1988) to measure emotional response of subjects. The PANAS scale consists of ten positive descriptive words regarding feelings and ten negative descriptive words regarding feelings. The subject is asked to indicate how often each word describes the subject's feelings. Possible alternatives for the subject to choose regarding frequency are: (1) very slightly or not at all; (2) a little; (3) moderately; (4) quite a bit; (5) extremely. The subject then enters the corresponding number next to the word which describes how often he or she experiences this feeling. The PANAS questions for the current study, located at Appendix B, asked the subject to rate his or her feelings about guns and knives. The subject responses were scored in the same manner as the other familiarity and emotional response questions, that is, the range of scores for each question was from a low of minus two to a high of plus two, with zero corresponding to a "moderate" response. The subject responses (N = 33) from the familiarity and emotional response questions were then scored and grouped into low and high familiarity and emotional response classifications to facilitate data analysis within SPSS.

After the data was loaded into SPSS for the subjects (N=33), another 2 X 2 ANOVA was performed to evaluate the effects of familiarity and emotional response on "hits" and "false alarms" of weapon detection responses. For the hits of the weapon detection responses the ANOVA indicated no significant main effects for familiarity, $F(1,30) = .03$, $p = .86$, nor were there any significant interactions between familiarity and emotional response, but there was a significant main effect for emotional response, $F(1,30) = 8.93$, $p = .01$. For the false alarms of the weapon detection responses the ANOVA indicated no significant main effects for familiarity, $F(1,30) = .33$, $p = .57$, or emotional response, $F(1,30) = .97$, $p = .33$, nor were there any significant interactions between familiarity and emotional response. Thus, while examining the combined data set which had the same familiarity and emotional response questions yielded no significant results, adding more detailed emotional response questions for the smaller sample (N = 33) did produce a significant main effect for emotional response, although it was in the positive direction instead of the negative direction as hypothesized. This significance of the main effect should be tempered due to the results of the tests for normality. The hits, $D(33) = .23$, $p < .001$, and the false alarms of the weapon detection responses, $D(33) = .39$, $p < .001$, were both significantly non-normal. In addition, a Pearson Correlation matrix shows that familiarity was strongly correlated with emotion ($r = .70$, $p < 0.01$), and emotion was strongly correlated with hits ($r = .59$, $p < 0.01$) as shown in Table 7 below. Using the Bonferroni method to control for Type I errors, a p-value of less than 0.017 (0.05/3) was required for significance. This p-value for significance applied to the two correlations that were mentioned, familiarity and emotion, as well as emotion and hits.

Table 7: Pearson Correlation Matrix for Familiarity and Emotion with Hits and False Alarms

	Hits	False Alarms	Familiarity	Emotion
Hits	1.000			
False Alarms	-.078	1.000		
Familiarity	.390	-.028	1.000	
Emotion	**.588***	-.146	**.696***	1.000
*. Correlation is significant at the 0.01 level.				

Application to Hypotheses

The results of the experiments with the combined data sets and the AFIT sample can be viewed in terms of their detection response biases using the graphical method in Hodos (1970). As mentioned earlier, a point on the y axis represents bias to report the absence of the signal, meaning that the subject had a conservative response bias when detecting the signal. The graphs of these detection results indicate that the combined data sets and the AFIT sample were characterized by the conservative response biases since both set of responses were in the positive bias quadrants. Since the x axis is expressed as a conditional probability of the false alarms, the response for the false alarms for both sets of subjects tended to be graphed close to the y axis. For example, the number of possible false alarms for the experiment was 600 total pictures minus 32 pictures which contained weapons, or 568 pictures which did not contain weapons. The x axis value of a subject who had a total of three false alarms during the experiment (which turned out to be the maximum number of false alarms that any subject experienced) would be 3 divided by 568 or 0.005, which would be graphed very close to the y axis due to the scale of the x axis. Figures 4 and 5 represent the results for the combined data sets and the AFIT sample respectively, using the Hodos (1970) graphical method.

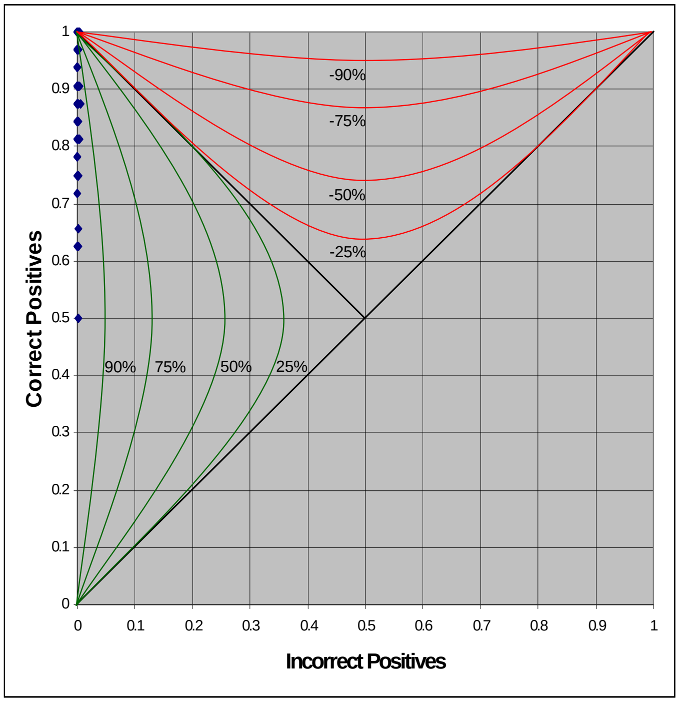

Figure 4: Results Displaying Percentage Bias – Combined Data Sets (Hodos, 1970)

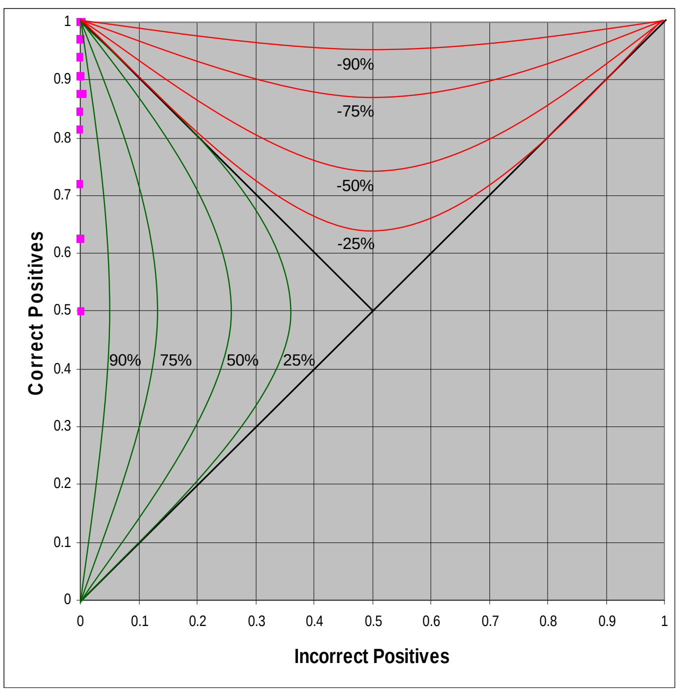

Figure 5: Results Displaying Percentage Bias – AFIT Sample (Hodos, 1970)

For the combined data sets, since there were no significant main effects for familiarity or emotional response, there was no support for H1 or H2. There was no significant interaction between familiarity and emotional response, so there was support for H3. For the AFIT sample, there was no significant main effect of familiarity, but there was a significant main effect upon emotional response. However, H1 proposes that a negative emotional bias will have a greater detection response, yet the majority of the subjects had a positive emotional bias towards weapons. This results in lack of support for H1 as well as H2. For the AFIT sample there was no significant interaction between familiarity and emotional response, so there was support for H3. These findings are summarized in Table 8.

Table 8: Support for Hypotheses

Hypothesis	Combined Data Sets	AFIT Sample
H1: Subjects who have a negative emotional bias against guns or knives will have a greater detection response than subjects who have a non-negative bias against them.	No significant effects. H1 not supported	Significant effects discovered for positive instead of negative bias. H1 not supported
H2: Subjects who are familiar with guns or knives will have a greater detection response than subjects who are not familiar with them.	No significant effects. H2 not supported	No significant effects. H2 not supported
H3: The familiarity and emotional bias factors are independent of one another.	No significant effects. H3 supported	No significant effects. H3 supported

Summary

The data analysis for the combined data sets and the AFIT sample indicate the impact each of the constructs had on the dependent variables of hits and false alarms. While increasing the sample size did not produce any significant effects on the dependent variables, adding more detailed emotional response questions seemed to produce a significant effect, albeit in a different direction than hypothesized. These results, possibilities for future work, and limitations will be discussed in Chapter Five.

V. Conclusions and Recommendations

Chapter Overview

The previous chapters have proposed research questions related to improving weapon detection rates for baggage screeners, reviewed the applicable research literature regarding the impact of familiarity and emotional bias upon attention and detection rates, developed hypotheses from the applicable research concerning how it would apply in a baggage screening scenario, designed the appropriate experiment to test the hypotheses, and collected and analyzed the data. This chapter reviews the results of this study and explains the significance of the results. Limitations of this study are noted, and recommendations for future research are proposed.

Conclusions of Research

The following sections will review each hypothesis and discuss how the data analysis supported or did not support each hypothesis. In those instances in which the data analysis did not support the hypothesis, explanations or possible reasons for the lack of supporting data will be offered. Recommendations for future research will be covered in a subsequent section.

Hypothesis One: Emotional Bias and Detection Response

Hypothesis one is restated below.

H1: Subjects who have a negative emotional bias against guns or knives will have a greater detection response than subjects who have a non-negative bias against them.

This hypothesis was not supported by the results of the data analysis for the combined data set. For the AFIT sample (N = 33), the hypothesis was not supported, but instead significant effects were noted for positive instead of negative emotional response. Also, emotional response and hits were highly positively correlated, which does not support this hypothesis. The reason for this positive correlation is most likely due to the nature of the subject pool. That is, since the majority of the AFIT sample (N = 33) were active duty military students who had no reservations about handling weapons, it should be safe to assume that they at least felt comfortable with guns or knives.

Thus, examining the combined data set did not aid in detecting a significant effect of emotional bias on the ability to detect weapons. However, the contribution of this study was to present questions that were more detailed and probing regarding emotional bias to the sample of students at AFIT (N = 33), which, in fact, did aid in detecting a significant effect of emotional bias on the ability to detect knives and guns. This finding suggested that subjects with a positive emotional bias may have a greater detection rate than that which was originally hypothesized. This could be due to the fact that very few participants had a negative emotional view of guns or knives and, therefore, the negative emotional response was not strong enough to detect a discernable effect. However, this finding tends to support the Pollyanna Principle, which states that people process pleasant information more accurately and efficiently than less pleasant information (Matlin and Gawron, 1979). The largely military subject pool clearly viewed guns and knives as positive items instead of negative items, and were able to quickly detect the presence of weapons when those who had less positive views of guns and knives were less able to detect these items. As a group, the largely military subject pool drew out this tendency, which no doubt contributed to its significance. Further research with other groups is needed to determine if this finding is an anomaly to this subject pool, or specific to these conditions.

Hypothesis Two: Familiarity and Detection Response

Hypothesis two is restated below.

H2: Subjects who are familiar with guns or knives will have a greater detection response than subjects who are not familiar with them.

This hypothesis was not supported by the results of the data analysis for the combined data set or for the AFIT sample (N = 33). The ANOVA reported no significant effects for familiarity. Noting the high correlation between familiarity and emotional response, the reason for this positive correlation is most likely due, again, to the nature of the subject pool. The majority of the AFIT sample (N = 33) were active duty military students who not only had no reservations about handling weapons, but also are required to take small arms training. As a result, they would be expected to be not only comfortable with guns, but also familiar with guns.

Hypothesis Three: Interaction Effects

Hypothesis three is restated below.

H3: The familiarity and emotional bias factors are independent of one another.

The combined data set and the AFIT sample (N = 33) did not have any significant interaction effects, which supports hypothesis three. This finding supports the notion that familiarity and emotional response are processed independently of one another. This finding is consistent with the limited literature which stated that there should be no interactions between familiarity and emotional response (Caharel et al., 2005; Bruce and Young, 1986).

Implications of Research

The results of this study indicate that there is a significant relationship between a subject's degree of emotional bias and the subject's ability to detect guns or knives in a baggage screening environment, yet not in the way the study originally hypothesized. As explained earlier, this could be an anomaly in which the Pollyanna Principle may have become a factor with the largely military sample. Further research using other non-military samples may provide results as originally hypothesized in this study. Also, in the present study the lack of negative emotions towards guns and knives in the AFIT sample did not provide much opportunity to detect a significant effect upon the hit rate. That is, if negative emotional bias was able to influence the hit rate of weapons, there were not enough instances of this bias to detect the effect.

The results of this study also show that researchers should give more consideration to the impact that positive emotional bias towards weapons could have in signal detection-type experiments. Much of the extant literature deals with the impact of the negative emotional response instead of the positive emotional that subjects have concerning dangerous items such as weapons. Perhaps this is influenced by the context in which weapons are normally presented in everyday life, which is as a means to inflict harm or injury on people. Nevertheless, this study shows that the largely military AFIT student sample has a predominantly positive view of guns and knives, and this attitude positively correlated with the ability to detect these weapons under time-constrained conditions. Therefore, an argument can be established around the idea of continuing research efforts with subjects such as gun or knife enthusiasts who would tend to have positive emotional responses to weapons such as guns or knives in a baggage screening scenario or other signal detection-type experiments.

If, in fact, further research demonstrates that these results are not an anomaly, then this knowledge can be used as a discriminator by those supervisors who are evaluating baggage screener applicants for future employment, or perhaps training can be designed to incorporate these emotional bias factors in order to reinforce them to current baggage screening employees. For example, knife or gun enthusiasts may require fewer hours of weapon detection training due to their increased ability to detect weapons than their non-enthusiast peers. Employing more people with the increased ability to detect weapons will help to increase detection rates and, as a result, improve airline security.

This research may be applied to other areas in which visual inspections play a key role such as manufacturing, in which defective manufactured parts must be detected and removed from the assembly line before delivery to the customer. Another area of application could be in visually inspecting homes or buildings for compliance with regulatory building codes. Yet another possible area for consideration could be visually inspecting financial documents such as during an auditing function to ensure quality work. These are examples of a few areas in which this research may prove to add value to the customers.

Limitations

Realism of Study

While the experiment attempted to simulate X-ray images in a baggage screening scenario, the quiet, isolated laboratory-like conditions do not approximate the reality of the noisy, distracting environment in which the baggage screeners work. The laboratory-like setting was used to provide a consistent environment across the subjects, and it served to focus the subject's attention on the detection task which would tend to increase the detection rate relative to the busy environment of the airline baggage handlers. This, along with the fact that the experiment did not attempt to conceal the weapons, would tend to increase the results of the experiment relative to the reality of the airline baggage screener environment.

Experience of Subjects

The experimental subjects were given about five minutes of training to look for specific examples of guns or knives, while TSA baggage screeners are trained for much longer periods to search for many other items than just these weapons. Therefore, it is doubtful that the subjects with this limited training would fare well as TSA baggage screeners. Conversely, professional TSA baggage screeners would most likely find this experiment a much easier task than their real-life baggage screening duties, as these simulated X-rays are collages of similar pictures that are rearranged to some degree.

Subject Pool

The data analysis revealed that the AFIT sample (N = 33), which was predominantly military and most likely had a positive emotional outlook concerning guns, was skewed heavily to indicate a positive emotional bias towards knives and guns, and thus did not have a normal distribution. This suggests that a note of caution is in order regarding the results of the ANOVA, as normality of the data is one of the assumptions of the ANOVA analysis. In addition, the large correlation between emotional response and familiarity shows that this subject pool was not only positively emotionally biased towards guns and knives, but also biased towards familiarity with guns and knives. This would tend to limit the variance in the familiarity factor, which may contribute to the non-normality of the distribution.

Recommendations for Future Research

While the findings of the current study are interesting, much more research can be done in this area. One suggestion would be to employ a sample which is averse to weapons such as guns and knives in a duplicate detection experiment and combine the results with the data from this study or Langhals (2011) to determine if a variance in detection can be discovered between the various samples. This would validate the hypothesis that emotional bias or familiarity can indeed be used as a significant discriminator in the detection of weapons. Another suggestion would be to use a more explicit emotional response measuring scale such as the PANAS-X (Watson & Clark, 1999) which has 60 items to measure emotional response instead of the 20 items used in this study. This would provide the researcher an even richer measure of emotional response to compare with the dependent variables of hits and false alarms. Another area of research includes varying the time that the subject is performing the baggage screening searches so that the subjects are allowed to have a break or two within the 40 minute experimental session. This would allow researchers to study the impact of rest periods

(Goolkasian, 1985) upon the subject's ability to detect weapons. Finally, an additional area to consider is to investigate how the detection rate varies by age (Bessette-Symons, 2008) or other demographics.

Summary

This study showed that while familiarity was not a significant factor in a subject's ability to detect weapons in a baggage screening environment, emotional bias was a significant factor in this detection ability, although not in the hypothesized direction. The study also showed that while adding more subjects to respond to the Langhals (2011) set of familiarity and emotional bias questions did not reveal any significant effect on the dependent variables of hits and false alarms, adding more detailed questions about the subjects' emotional responses did produce significant effects on hits and false alarms. While further research is required to determine if other factors such as age or task fatigue contribute to a subject's ability to detect weapons in a baggage screening scenario, this study provides a method and direction from which to launch additional studies.

If weapon detection rates can be incrementally improved by methods resulting from this or other studies, then fewer items that threaten the security of airline passengers and aircraft crew members will be on board commercial aircraft. Increased weapon detection rates may help prevent another series of events such as the September 11, 2001 attacks from occurring. If the weapon detection rates experience this increase while keeping manpower costs steady or decreasing, then the airlines and the flying public, including Air Force personnel, will emerge as the winners while enjoying the benefits of securely flying America's airways.

Appendix A: Human Subject Exemption Approval

DEPARTMENT OF THE AIR FORCE
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OHIO

04 Jan 2012

MEMORANDUM FOR LT COL BRENT T. LANGHALS

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2950 Hobson Way
Wright-Patterson AFB, OH 45433-7765

SUBJECT: Approval for exemption request from human experimentation requirements (32 CFR 219, DoDD 3216.2 and AFI 40-402) for a study of the Impact of Self-Reported Biases and Familiarity in a Baggage Screening Context.

1. Your request was based on the Code of Federal Regulations, title 32, part 219, section 101, paragraph (b) (2) Research activities that involve the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior unless: (i) Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) Any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

2. Your study qualifies for this exemption because you are not collecting sensitive data, which could reasonably damage the subjects' financial standing, employability, or reputation. Further, the demographic data you are collecting, if any, and the way that you plan to report it cannot realistically be expected to map a given response to a specific subject.

3. This determination pertains only to the Federal, Department of Defense, and Air Force regulations that govern the use of human subjects in research. Further, if a subject's future response reasonably places them at risk of criminal or civil liability or is damaging to their financial standing, employability, or reputation, you are required to file an adverse event report with this office immediately.

JEFFREY A. OGDEN, PH.D.
AFIT Research Reviewer

Appendix B: Study Questionnaire

1. What is your participant number?

2. What is your gender?

3. What is your ethnicity?

	White/Caucasian	_______
	Black/African American	_______
	Hispanic	_______
	Asian	_______
	Native American	_______
	Other	_______

4. What country are you a citizen of?

5. What is your age?

6. On a scale of 1 to 5, please answer whether or not you agree with the following statements (circle one of the numbers). There is no right or wrong answer.

	Disagree				Agree
Seeing a gun makes me uncomfortable.	1	2	3	4	5
I have personally fired a gun in the past.	1	2	3	4	5
I can distinguish a handgun from a rifle.	1	2	3	4	5
Seeing a knife makes me uncomfortable.	1	2	3	4	5
I am familiar with guns.	1	2	3	4	5
I am familiar with knives.	1	2	3	4	5

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. **Indicate to what extent each item expresses your feelings about guns.** Use the following scale to record your answers.

1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

_____ interested	_____ irritable
_____ distressed	_____ alert
_____ excited	_____ ashamed
_____ upset	_____ inspired
_____ strong	_____ nervous
_____ guilty	_____ determined
_____ scared	_____ attentive
_____ hostile	_____ jittery
_____ enthusiastic	_____ active
_____ proud	_____ afraid

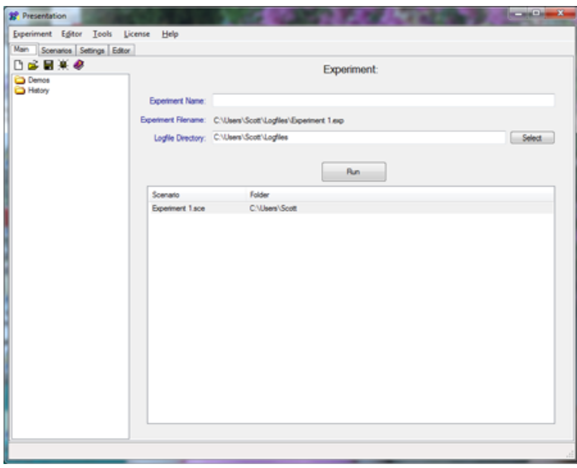
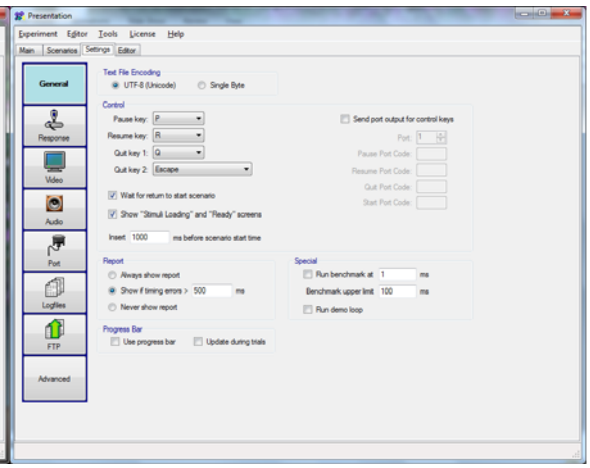
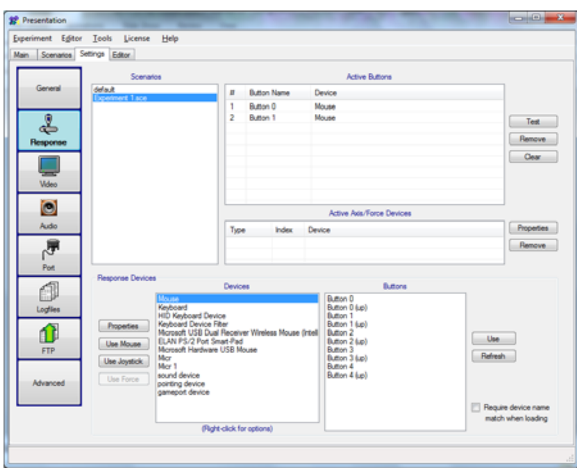
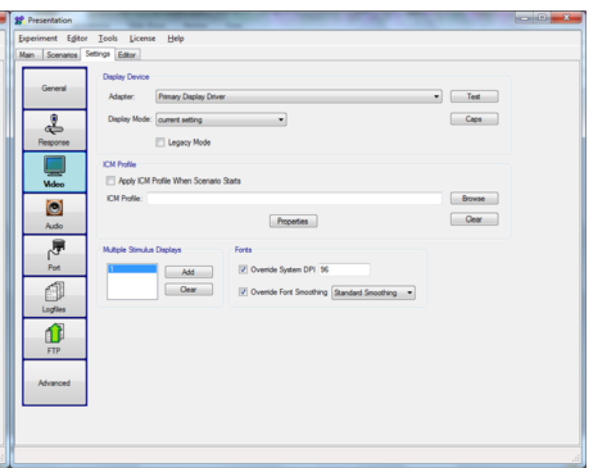
This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. **Indicate to what extent each item expresses your feelings about knives.** Use the following scale to record your answers.

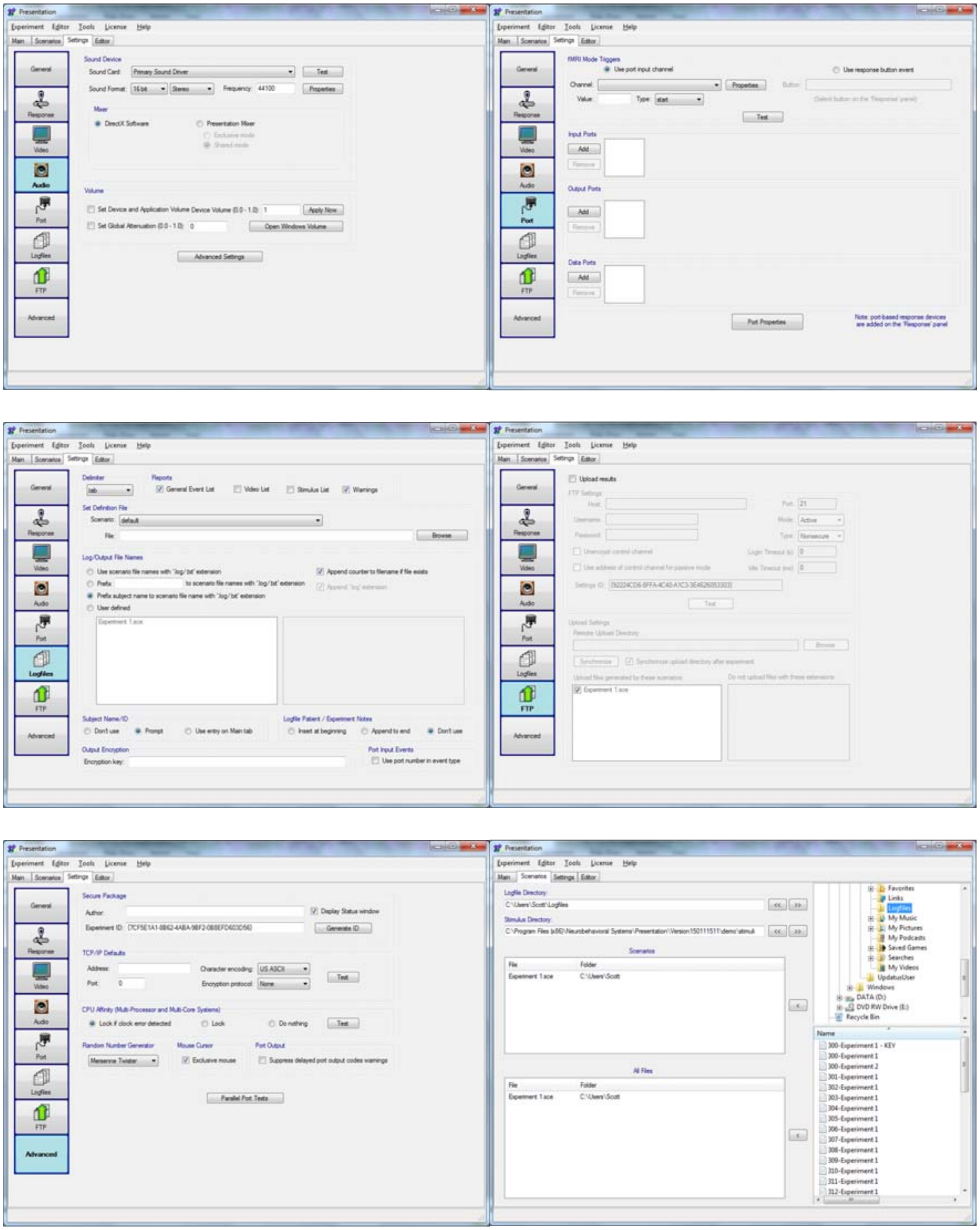
1	2	3	4	5
very slightly or not at all	a little	moderately	quite a bit	extremely

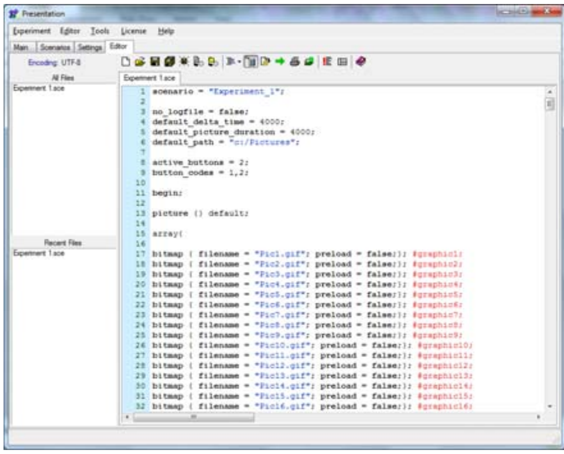
_____ interested	_____ irritable
_____ distressed	_____ alert
_____ excited	_____ ashamed
_____ upset	_____ inspired
_____ strong	_____ nervous
_____ guilty	_____ determined
_____ scared	_____ attentive
_____ hostile	_____ jittery
_____ enthusiastic	_____ active
_____ proud	_____ afraid

Appendix C: Presentation Software Configuration (Langhals, 2011)

Presentation Software was designed to allow control of all aspects of the experiment. Its designers developed the software to allow many preset functions, thus reducing the amount of code required to operate the experiment. The following screen captures indicate the preset values used for the detection experiment described previously.

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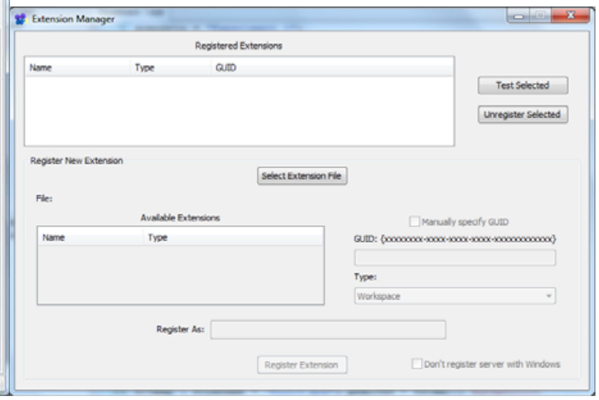
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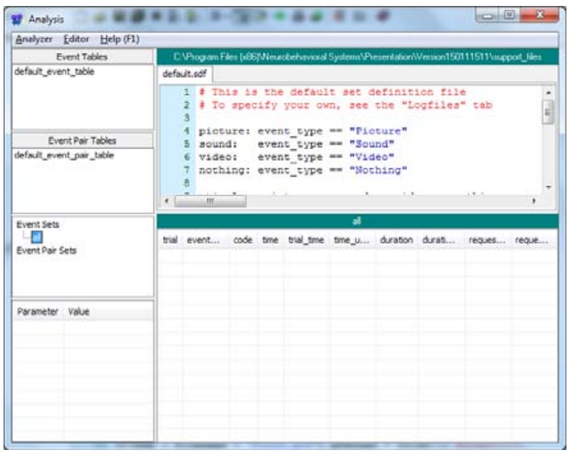
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To specify your own, see the "Logfiles" tab
picture: event_type == "Picture"
sound: event_type == "Sound"
video: event_type == "Video"
nothing: event_type == "Nothing"
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Appendix D: Presentation Code (Langhals, 2011)

The following code represents the core code used for the experiment described in this study. Together with the preset configurations presented in Appendix C, this code represents all that is needed to begin replicating this study.

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bitmap { filename = "Pic576.gif"; preload = false;}; #graphic576;
bitmap { filename = "Pic577.gif"; preload = false;}; #graphic577;
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bitmap { filename = "Pic581.gif"; preload = false;}; #graphic581;
bitmap { filename = "Pic582.gif"; preload = false;}; #graphic582;
bitmap { filename = "Pic583.gif"; preload = false;}; #graphic583;
bitmap { filename = "Pic584.gif"; preload = false;}; #graphic584;
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bitmap { filename = "Pic598.gif"; preload = false;}; #graphic598;
bitmap { filename = "Pic599.gif"; preload = false;}; #graphic599;
bitmap { filename = "Pic600.gif"; preload = false;}; #graphic600;
bitmap { filename = "Pic601.gif"; preload = false;}; #graphic601;
}

graphics;

#wavefile { filename = "piercer.wav"; } s1;
```

```
#sound { wavefile s1; } sound1;

trial {

  picture {

    background_color = 255,255,255;
    box { height = 1; width = 1; color = 225,225,225; };
    x = 0; y = 0;
    } pic1;
    time = 0;
}
  trial1;

trial {

 #  sound sound1;
  # time = 0;

  picture {

    background_color = 255,0,0;
    box { height = 1; width = 1; color = 225,225,225; };
    x = 0; y = 0;
  } pic2;
   time = 0;
}
  trial2;

begin_pcl;

#eye_tracker tracker = new eye_tracker( "ASLEyeTracker" );
#tracker.send_string( "port=1" );
#tracker.start_tracking();
#tracker.start_data( dt_position, true );
#tracker.start_data( dt_pupil, true);


loop

   int i = 1

until

   i > graphics.count()
```

```
begin

   if (i == 650 ) then

     graphics[i].load();
     pic2.set_part( 1, graphics[i] );
     trial2.present();
     graphics[i].unload();

     i = i + 1


   else


     graphics[i].load();
     pic1.set_part( 1, graphics[i] );
     trial1.present();

     graphics[i].unload();

     i = i + 1

   end

end
```

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Vita

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CIO Support Services Manager – HQ AF Materiel Command, Wright-Patterson AFB, OH
(October 2006 – Present)

- Provided program management and planning strategies for the AF Nuclear Warfare Center (AFNWC) and AF Global Strike Command (AFGSC) as they relate to AF and AFMC IT.
- Provided direct support to the AFMC CIO for the management of the 800+ IT systems in the AFMC Portfolio budgeted at over $400M annually, oversaw the proper reporting to AF and DoD organizations.
- Managed the Information Technology Service Management (ITSM) Program, an AFMC program for consolidating IT Help Desks and implementing ITSM processes at AFMC bases and sites. Advised senior management of best corporate policies and strategies using framework standards such as the Information Technology Infrastructure Library (ITIL) to accomplish the most efficient Help Desk consolidation across the Command. Led the ITSM Integrated Product Team (IPT), composed of Deputy Chief Information Officers (DepCIOs) and Subject Matter Experts (SMEs) from each of the ten AFMC bases and sites, to accomplish program goals.

AFMC Lead Network Infrastructure Architect – HQ AF Materiel Command, Wright-Patterson AFB, OH
(April 2005 – Present)

- Performed 255+ authoritative IT policy reviews for AFMC, AF and DoD publications
- Provided policy and guidance for AFMC compliance with the AF Network Operations (AFNetOps) and AF Cyber Command organizations.

- Led effort to develop and implement the transition of AFMC organizations and associated funding and manpower to the AFNetOps organizations and business processes.
- Provide authoritative architecture guidance and advice for NDAA system architecture artifact reviews on AFMC IT systems.
- Developed the AFMC Capstone Architecture views for NDAA reconciliation, which linked top-level AFMC business processes with the AF Enterprise Architecture and ensured that nine AFMC IT systems received successful NDAA certification.
- Presented and defended AFMC IT issues for the AF-wide Architecture IPT reviews and provided authoritative guidance during DoD and AF policy document reviews on IT issues.
- Developed the communication channel architecture views of the AFMC Battle Lab and Crisis Action Team by working with Operations and Engineering personnel from AFMC/DO and AFMC/EN, respectively.
- Developed the AFMC IT Roadmap in support of the FY08 Program Objective Memorandum (POM), which provided guidance to AFMC program managers by relating their individual initiatives to broader enterprise efforts.

PROFESSIONAL EDUCATION

Air War College (2008)
Enterprise Architecture (EA) Program Certificate (2008)
Information Technology Infrastructure Library (ITIL) v3 Foundation Certification (2007)
Chief Information Officer (CIO) Certificate (2001)

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14. ABSTRACT A common assumption is that items that evoke strong emotions are more easily recognized than items that do not evoke strong emotions (Bessette-Symons, 2008). For example, items such as guns or knives may evoke strong emotions within some people, and it may be presumed that these items may be more easily recognized by people that have strong emotions associated with them. If this is true, then perhaps these people would be more apt to locate these items in situations such as baggage screening services that rely on accurate detection of weapons for the public's safety. This study explores this reasoning to determine if emotional biases or familiarity impact the ability of subjects to detect guns or knives in a baggage screening scenario. Subjects were administered a questionnaire to determine their degree of emotional bias and familiarity with guns or knives, and then were asked to detect guns or knives in a simulated baggage screening scenario. The results indicate that while increasing the sample size of the subject pool did not produce any significant effects on the number of weapon detections, adding more detailed emotional response questions seemed to produce a significant effect for positive emotion rather than negative emotion.			
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