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A Comparison of Micro-Expression Training Methods

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Walden University
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Abstract

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Dissertation Submitted in Partial Fulfillment

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Abstract

Micro-expressions are brief facial expressions that last for 500 milliseconds or less and show the true emotional state of an individual when he or she is displaying a false emotional state. There are currently 2 different methods to train individuals to recognize micro-expressions—picture-based and video-based. Numerous organizations use micro-expression training as part of a deception detection program, but little research has been conducted on training outcomes, and no research has investigated the difference between the methods. In this quantitative study based on Darwin's theory of the universality of emotional expression, a control group experimental design was used to determine if there is a difference in training outcomes, as measured by post-training accuracy rates of overall and emotion-specific micro-expression identification, between the 2 current micro-expression training methods and no training. A total of 196 participants recruited from Amazon's Mechanical Turk community were randomly assigned to a picture-based training, video-based training, or no training control group. The online training and post training test were delivered via a computer-based training platform. MANOVA, ANOVA and *t* tests were run to determine the differences between the groups. Results indicated that participants in both picture-based and video-based training groups showed a significant increase in their ability to recognize micro-expressions compared to those in the no training group, but did not differ from each other. The study provides an increased understanding of micro-expression training outcomes that may contribute to the training of numerous law enforcement, security, and human resources professionals.

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Dedication

To the people who inspired the love of reading in me, my adopted parents Karen and Al, my wonderful wife who brought me back from the brink, and sprout.

Acknowledgments

I could not have completed this dissertation if it was not for the constant support of a number of individuals. First I would like to thank my wife, Dr. Brett Robinson for all of her support, kind words, and knowhow. If it was not for you I would not have been able to get through not only my dissertation but my schooling. You have been my rock through all of this and having seen you go through this process made it so much more bearable for me.

I would also like to thank Dr. Kimberley Cox for all her support which began while I was still considering Walden University and her immediate interest in my area of research which made my choice of school, supervisor, and overall dissertation process far less stressful.

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Chapter 1: Introduction to the Study

Micro-expressions are brief facial expressions which last 500 milliseconds or less and show the true emotional state that is felt by an individual. Micro-expressions are shown when an individual is displaying a false emotional state through their facial expression in a high stress situation. The experience of stress while concealing one's true emotional state leads to the true emotional state being displayed as a micro-expression due to an attempt by both the prymidal and extra-prymidal tracts of the brain attempting to control the facial display (Ekman & Friesen, 1969; Rinn, 1984).

Currently there are two methods for training individuals to recognize micro-expressions. One method involves picture-based training, the second method involves video-based training. Recent publications have outlined the manner in which micro-expressions are displayed, providing an increased understanding of micro-expression displays. An increased understanding of micro-expression displays has influenced micro-expression training methods (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011; Rinn, 1984). Understanding which method, if either, provides an individual with an increased ability to recognize micro-expressions as they are displayed naturally will allow for improved training outcomes.

In the context of this study, the definition of micro-expressions is as stated in the Yan et al. (2013) study. This is micro-expressions reach the highest intensity of emotional display 1/3 of the way through the emotional display and the average duration is 361 milliseconds.

Because micro-expression recognition is used by a number of government agencies in a variety of settings such as airport security, anti-smuggling operations, and police interrogations (United States Government Accountability Office [U.S. GAO], 2013), my findings on training outcomes may assist individuals in security settings in obtaining the training that will provide them with the highest likelihood of recognizing micro-expressions in these settings, potentially resulting in increased job performance.

The following sections of this chapter include summaries of the current literature on micro-expressions, their neurological basis, and training methods for identifying them. In the problem statement, I highlight the relevant gaps in the current literature and identify the need for a comparison of the current training methods. In this chapter, I address the current shortcomings in the field of micro-expression training, as well as the basis of micro-expression displays.

Background

Micro-expressions have been shown to display true emotional states (Ekman & Friesen, 1969; Rinn, 1984). Because of this link, government entities such as police forces and intelligence organizations, private sector companies such as fraud investigators, and individuals have undertaken micro-expression training since it became available to the public in the late 1990s. Ekman and Friesen originally conceptualized micro-expressions displays as an instant onset at the highest intensity of the emotional portrayal (1969). The researchers believed that micro-expressions would instantaneously achieve their highest intensity of the emotional display and last for a period of

approximately 200 milliseconds before reverting to the previously shown emotion (Ekman & Friesen, 1969).

The micro-expression research conducted in the 1960s through the 1980s and an increased understanding of the neurological basis for micro-expressions led to the creation of micro-expression training programs in the 1990s. The training was available as both computer-based and in-person instructional sessions involving the same instructional material and methodology (Matsumoto & Hwang, 2011). The training displayed used a picture of a neutral face that was then superimposed with a picture of the highest level of the emotional intensity for 200 milliseconds and subsequently returned to the neutral face at the end of the 200 milliseconds.

Yan et al. (2013), however, found that micro-expressions are not displayed in the manner which previous research had theorized. Rather, Yan et al. (2013) found that micro-expressions are displayed in a positively skewed curve to reach the highest intensity of the emotional display. Yan et al. (2013) showed that the highest intensity of the emotional display is reached approximately 1/3 of the way through the displays of the micro-expressions and lasts for an average duration of 17 milliseconds. The researchers also found that the highest intensity of the emotional display is displayed for a shorter duration than previously research had hypothesized, 17 milliseconds on average versus 200 milliseconds previously reported (Yan et al., 2013). This research led to the creation of micro-expression training in 2014, which displayed the micro-expressions in accordance with Yan et al.'s model. The newer training involved edited videos of the micro-expressions (Kane & O'Byrne, 2014).

The picture and video-based models of micro-expression training have been validated in their ability to train individuals to recognize micro-expressions (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011). The picture-based model using 42 micro-expression displays receives higher post-test scores on a post-test of micro-expression recognition of the seven emotional states, but does not properly depict how micro-expressions are shown naturally because only the highest intensity of the emotional display is depicted in the post-test. The video-based method using 42 micro-expression displays has lower post-test scores on a post-test of micro-expression recognition of the seven emotional states in comparison to the picture-based method, but trains individuals to recognize micro-expressions naturally. It is currently unknown if these differences in training have an impact on an individual's ability to recognize micro-expressions naturally.

Due to the U.S. GOA's (2013) oversight of the Transportation Security Agency (TSA) deception detection program, Screening Passengers by Observation Techniques (SPOT), as well as interest in the private and public sectors in recent years, there is a need for the scientific validation of training in the field of deception detection. This need for further scientific investigation compelled me to undertake this study to understand the optimal method to provide micro-expression training.

Problem Statement

Micro-expressions are facial expressions lasting 500 milliseconds or less that show an individual's true emotional state (Ekman & Friesen, 1969; Rinn, 1984; Yan et al., 2013). Micro-expressions are created when an individual is displaying a false

emotional display through facial expressions in a high stress situation. The experienced stress of concealing ones true emotional state leads to both the pyramidal and extrapyramidal tracts of the brain attempting to control the displayed facial expression. The pyramidal and extrapyramidal tracts are the portions of the brain responsible for voluntary and involuntary movements respectively. The displays of a false emotional state through facial expressions in a high stress situation results in the extrapyramidal tract gaining momentary control of the facial muscles, leading to the displays of the individual's true emotional state for 500 milliseconds or less during the time when the false emotional state is being displayed presented (Rinn, 1984).

There are currently two methods to train individuals to recognize micro-expressions. These training methods have only been tested in laboratory conditions, resulting in accuracy rates of identifying micro-expressions between 65% and 95% for both methods (Kane & O'Byrne, 2014; Matsumoto, & Hwang, 2011). The traditional training method involves the presentation of pictures in which a neutral face is shown followed by a picture of a high intensity emotion shown for 200 milliseconds before reverting back to the picture of the neutral face (Matsumoto & Hwang, 2011). The second training method uses videos which begin with a neutral face followed by the displays of a micro-expression in accordance with research conducted by Yan et al. (2013), which presents the highest intensity about 1/3 of the way through the micro-expressions in displayed accordance with how they present naturally (Kane & O'Byrne, 2014; Yan et al., 2013). The traditional picture training method has an overall higher accuracy rate in

training with a mean score of 78% (Matsumoto & Hwang, 2011) compared to the video training method, which has a mean accuracy rate of 67% (Kane & O'Byrne, 2014).

Emotional displays through facial expressions are coded on a seven point scale of emotional display intensity developed in the Facial Action Coding System (FACS; Ekman, Friesen, & Hager, 2002). The traditional model of micro-expression training portrays only the highest emotional intensity. The video training method shows the progression from a neutral face to the highest intensity, displaying the spectrum of emotional intensity. Differences in accuracy rates after training may be the result of the longer exposure of the highest intensity of the emotional display in the picture-based training method (Kane & O'Byrne, 2014).

Prior to 2013, the limited availability of high-speed video recording made it difficult to perform research on how micro-expressions manifest physically. Initial research on micro-expressions was conducted in the 1960s and 1970, showing that the highest emotional intensity was reached instantaneously and lasted approximately 200 milliseconds (Ekman & Friesen, 1974). Yan et al. (2013) subsequently disproved and replaced Ekman and Friesan's model of micro-expression portrayal through research on how micro-expressions are portrayed utilizing high speed cameras. Since 2013, researchers using high speed cameras have found that micro-expressions reach the highest intensity of the emotional display approximately 1/3 of the way through the displays of the micro-expressions (mean highest intensity onset at 139.91 milliseconds) and lasts for 17 milliseconds (Yan et al., 2013). It was also found that the highest

intensity of the emotional display is exhibited for a shorter duration than previous researchers had hypothesized (Yan et al., 2013).

Micro-expression training prior to 2013 utilized still photos, as it was believed at that time that this training methodology approximated the manner in which micro-expressions were displayed. The picture-based process of micro-expression displays showed a neutral face, followed by the highest intensity of the emotion shown for 200 milliseconds, and then the neutral face would be shown again (Ekman & O'Sullivan 2006; Matsumoto & Hwang, 2011). In accordance with the research conducted by Yan et al. (2013), Kane and O'Byrne (2014) developed a method that used high speed videos to train individuals to recognize micro-expressions. Both the traditional and video training methods are designed to train individuals to recognize micro-expressions as naturally displayed.

Despite known mean accuracy rates for each of the training methodologies, no research has been conducted to assess the differences, if any, between the two methods in their ability to successfully train individuals to recognize micro-expressions displayed. Micro-expression recognition has been incorporated into a number of public and private sector security personnel and deception-detection training programs. Because there is an increased demand for scientific validation of these training methods (U.S. GAO, 2013), my primary objective in this study was to compare each method's ability to train individuals to accurately recognize micro-expressions as they are displayed naturally.

Purpose of the Study

The purpose of this study was to quantitatively investigate the differences, if any, between the post training accuracy rates of overall and emotion-specific micro-expression identification outcomes of the two current micro-expression training methods. I compared the overall and emotion specific micro-expression identification outcomes of the two training methods and no training. The independent variable was the instructional method, while the overall and emotion-specific micro-expression identification were the dependent variables.

Research Questions and Hypotheses

I developed two research questions to identify any differences between instructional methods.

Research Question 1: What is the difference in overall accuracy rate to detect micro-expressions between the picture-based training method, the video-based training method, and no training?

$H_0$1: There is no significant mean difference in overall accuracy rate between the picture-based training method, the video-based training method, and no training?

$H_1$1: There is a significant mean difference in overall accuracy between the picture-based training method, the video-based training method, and no training?

Research Question 2: What is the difference in ability to recognize specific facial expressions within and between the picture-based training method, the video-based training method, and no training?

$H_0$2: There is no significant mean difference in ability to recognize specific facial expressions within and between the picture-based training method, the video-based training method, and no training.

$H_1$2: There is a significant mean difference in ability to recognize specific facial expressions within and between the picture-based training method, the video-based training method, and no training.

Theoretical Framework

The theoretical basis of this study was Darwin's (1872) theory of the universality of emotional expression. Darwin stated in this book *The Expressions of the Emotions in Man and Animal* that he observed humans and animals displaying emotional expressions in the same manner within each species and that he believed all expressions were shown in the same manner within each species. Though universality of all emotions has been disproven there are at least seven universal emotions within humans. I built on Darwin's framework using the work of Ekman and Friesen (1969), Matsumoto and Hwang (2011), Yan et al. (2013), Shen, Wu, and Fu, (2012), and Kane and O'Byrne (2014). Ekman and Friesen (19690 were the first researchers to create a working theoretical model and explanation of micro-expressions. Their research showed that micro-expressions are created, that they portray the universal emotions, and that they are present in high stress situations. These findings would later be expanded upon by Rinn (1984) to include a neurological explanation for the creation of micro-expressions. Matsumoto and Hwang (2011) were the first to show that it is possible to train individuals to recognize micro-expression, have them retain the knowledge, and be able to apply it at a later time.

Yan et al. (2013) provided a current understanding of how micro-expressions are displayed, while Shen et al. (2012) provided an understanding of how individuals are able to recognize micro-expressions, indicating that a total displays time of or over 200 milliseconds is able to be accurately recognized by individuals. Finally, Kane and O'Byrne (2014) showed that it is possible to train individuals to recognize micro-expressions displayed in the manner stated in the Yan et al. (2013) findings. These findings will be discussed in greater detail in Chapter 2.

In this study, I used the seven universal emotions as the basis for micro-expression displays (Boucher & Carlson, 1980; Ekman, Friesen, & Ellsworth, 1972; Izard, 1971; Matsumoto, 1992). Micro-expression training is limited to the seven universal emotional expressions to exclude cultural differences associated with non-verbal communication (Ekman, 1977a). The seven universal facial expressions comprise the seven emotional states of anger, contempt, disgust, fear, happiness, sadness, and surprise (Boucher & Carlson, 1980; Ekman & Keltner, 1970; Ekman et al., 1972; Izard, 1971; Matsumoto, 1992).

Training and testing for micro-expressions has been empirically supported for the seven universal emotions (Boucher & Carlson, 1980; Ekman & Keltner, 1970; Ekman et al., 1972; Izard, 1971; Matsumoto, 1992). In this study, I used the two current micro-expression training methods (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011) to determine if there is a difference in natural micro-expression recognition between the training methods.

Nature of the Study

This quantitative study involved a control group experimental design. Participants were randomly assigned to one of three groups and asked to complete a computer-based training program in micro-expression recognition that used pictures or high-speed videos. These three groups were the control group, the picture-based training group, and the video-based training group. All groups completed a micro-expression recognition test that consisted of 42 videos of micro-expression displays of the seven universal emotions displayed in accordance with the Yan et al. (2013) findings. The control group completed the micro-expression recognition test and then completed the training of their choice, or no training in accordance with ethical principles of research (Gibbon, 2002). Training was provided in a manner consistent with previous studies on micro-expression recognition (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011). The participants in the experimental groups completed the training method of the experimental group in which they had been placed and then completed the micro-expression recognition test. The micro-expression testing was conducted by showing the participants a video of a micro-expression and then asking them to select which of the seven universal expressions was displayed, with this task being repeated a total of 42 times.

The data were collected through Amazon's Mechanical Turk (MTurk) via an online training course including the post-test. The data from the post-test showed which emotion was selected for each micro-expression displays, and was then coded as either correct or incorrect. I then analyzed the data using IBM SPSS to answer the research questions.

Definitions

Micro-expression: An involuntary facial expression which lasts between 150 and 500 milliseconds and shows the true emotional state of the individual (Ekman & Keltner, 1970; Ekman et al., 1972; Yan et al., 2013).

True emotional state: The emotional state of an individual, whether displayed or not (Ekman & Keltner, 1970; Ekman et al., 1972).

Universal emotional expressions: Emotional displays which appear in the same manner across all healthy, normatively facially-physically-developed individuals (Ekman & Keltner, 1970; Ekman et al., 1972).

Picture-based micro-expression training: A training method, which culminates in the testing of micro-expressions, in which a neutral face is shown followed by a picture of a high intensity emotional displays of the same individual for 200 milliseconds before reverting to the original picture of the individual's neutral face (Matsumoto & Hwang, 2011).

Video-based micro-expression training: A training method, which culminates in the testing of micro-expressions, in which a neutral face is shown, followed by an increase in emotional intensity displays to the highest level, which is displayed for 17 milliseconds prior to decreasing and reverting to a neutral face. The micro-expression displays lasts for 361 milliseconds (Kane & O'Byrne, 2014; Yan et al., 2013).

Assumptions

Previous researchers have addressed ethnic and cultural differences in identifying the seven universal emotions and have found no significant differences (Ekman &

Keltner, 1970; Hurley, 2012; Matsumoto, 1992; Matsumoto & Hwang, 2011). Age specific identification has not been addressed in these studies, resulting in my assumption that there is no difference in an individual's ability to properly recognize the seven universal emotions based on age.

I used MTurk to recruit participants. Individuals who are part of the MTurk participant community are assumed to be familiar with online-based training because MTurk is an online training and data collection system (Amazon, 2017).

Scope and Delimitations

The ability to properly recognize an individual's emotional state assists in interpersonal communication, and the ability to recognize micro-expressions is an additional aspect of emotional recognition and communication (Matsumoto & Hwang, 2011). In this study, I sought to understand a specific aspect of micro-expression recognition. A between methods comparison of the training outcomes was selected as the focus of the study to determine if one of two training methods versus no training results in a greater ability to recognize micro-expressions. Because this is a relatively unexplored field I reviewed a majority of the peer-reviewed studies published on the topic.

I recruited study participants through MTurk. MTurk allows for recruitment by demographics, allowing the researcher to obtain a convenience sample of its members. I thus limited participants to those who had a computer and internet access, were members of MTurk, and who viewed the study. The study was also limited to those who were

proficient in English, and those living in the United States to ensure that the training was understood.

As a result of the convenience sample, the results of this study may not be generalizable. Though alternate data collection methods could have been used, I selected MTurk for its ability to collect data online while applying qualifiers to participants including geographic location. The ability to collect data online was a primary concern because I reside in Canada and wished to obtain a sample from the U.S. population. Using alternative data collection methods such as in person training would have resulted in variations in training as well as logistical difficulties, which were avoided with use of MTurk.

Response time was not recorded because the Learning Management Software (LMS) I used did not allow for it. The LMS I used to deliver the training was unable to record the length of time spent on a question prior to the response being entered. The total amount of time spent on a question could be obtained, though if participants re-evaluated their response prior to moving to the next question, the obtained data would be faulty. Though response time would be a valuable data set in understanding how micro-expressions are viewed and interpreted, collecting this data was not feasible in the context of this study due to the limitations of the LMS.

Limitations

I designed this study to allow participants to complete the training and testing online. Online data collection may have allowed for individuals who received similar training, either formally or informally, to participate. To address this, participants were

screened for previous micro-expression and emotional recognition training as part of the consent process. Previous micro-expression and emotional recognition training screening was done electronically with the question, “Have you previously received any training on emotional recognition and/or micro-expression recognition?” The participants then selected either “Yes” or “No.” Because the training was done electronically, the participants were not able to seek assistance if they were confused by the question, potentially resulting in individuals who had received training on this subject selecting “No.” Individuals who had received previous micro-expression and/or emotional recognition training could affect the validity of the study, though the use of randomization for placing participants into groups minimized the impact this had, if any, on the studies outcomes.

The sampling strategy— convenience sample—was a limiting factor given that it does not allow for generalization of the findings. The length of the training and testing may have also limited participation in the study. Because the training and testing took between 30 and 45 minutes to complete, it is likely that numerous potential participants disregarded the study due to the required time commitment. In an attempt to counter this, a financial incentive of $3.00 for participating and completing the training and test was provided.

Significance of the Study

This research will add to the deception detection literature, specifically the emotional deception detection literature on training practices for micro-expression recognition. An increased understanding of micro-expressions and advancements in

technology have resulted in the development of multiple micro-expression training methodologies. This study contributes to an in depth understanding of the benefits of each training method and shows if a single training methodology provides an increased ability to recognize naturally-expressed micro-expressions. The results from this study will assist individuals in both private- and public-sector security to properly select the appropriate training for their organizational needs, while providing an increased understanding of micro-expression recognition and training and increasing communication ability for those who undertake micro-expression training.

Summary

Micro-expressions are brief facial expressions that last for 500 milliseconds or less and are shown when an individual is concealing their true emotional state in a high stress situation (Ekman et al., 1972; Rinn, 1984). Micro-expression detection has become an important part of deception detection programs including the TSA SPOT program (U.S. GAO, 2013). This emphasis on micro-expression recognition has led to the development of two training methods to recognize micro-expressions. The first of these methods uses picture-based training (Matsumoto & Hwang, 2011), while the second uses video-based training (Kane & O'Byrne, 2014). Yan et al. (2013) outlined the manner in which micro-expressions are displayed, though there is a gap in the scholarly research on whether one of the two training methods results in increased ability to recognize micro-expressions.

In Chapter 2, I provide an in-depth overview of micro-expressions. The chapter begins with a discussion on the universality of emotions (Darwin, 1872; Ekman &

Keltner, 1970; Matsumoto, 1992). Next, I provide an analysis of what micro-expressions are (Rinn, 1984), how micro-expressions are displayed (Yan et al., 2013), and the ability to recognize and training to recognize micro-expressions (Ekman et al., 1972; Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011).

Chapter 2: Literature Review

Currently, there are two methods of training individuals to recognize micro-expressions. However, no research has been conducted on the difference, if any, between these two training methods. One method is based on the use of pictures and the theoretical presumption that micro-expressions manifest themselves instantaneously with an average duration of 200 milliseconds (Ekman & Keltner, 1970; Matsumoto & Hwang, 2011). The second method uses videos to train individuals to recognize micro-expressions in a manner consistent with findings from Yan et al. (2013) that showed micro-expressions displayed in a positively skewed curve to reach the highest intensity of emotional expression (Kane & O'Byrne, 2014). I conducted this study to determine if there is a difference in outcomes, as measured by the accuracy rate for overall and emotion specific micro-expression identification, between these two training methods and no training.

There is a limited body of knowledge on micro-expressions. Micro-expression research began in the 1960s when Haggard and Isaacs (1966) were analyzing films of therapy sessions frame by frame to identify nonverbal cues in the session between patient and psychologist. During this analysis, the researchers noted that there were brief facial emotional displays that otherwise would typically go unnoticed. Since that time, a limited number of studies have been conducted on micro-expressions and training to recognize them. To date, only two studies have addressed training individuals to recognize micro-expressions (Kane & O'Byrne, 2014; Yan et al., 2013), while a number have addressed how micro-expressions and universal facial expressions are displayed (Boucher &

Carlson, 1980; Ekman & Keltner, 1970; Ekman et al., 1972; Haggard & Isaacs, 1966; Hill, 2003; Izard, 1971; Matsumoto, 1992; Yan et al., 2013; Shen et al., 2012).

In this chapter, I provide an overview of the search strategy I used to gather relevant literature for review. Additionally, I address the theoretical framework, and then offer an exhaustive review of the literature on micro-expressions, micro-expression training, and the physiological ability to recognize brief visual stimuli. The chapter concludes with an overview of the current gaps in the literature on micro-expressions while addressing the benefits of this training in the police and security deception detection realm.

Literature Search Strategy

I used a comprehensive literature search strategy to find relevant literature for the study. I searched multiple databases for peer-reviewed journals, government documents, and books. The initial search was conducted using the multidisciplinary databases ProQuest Central and Academic Search Complete. This was followed by searches in PsycINFO, PsycARTICLES, PsycCRITQUES, SocINDEX, ScienceDirect, and Google Scholar. Key search terms were *micro-expressions, micro-expression, microexpression, microexpressions, micromomentary expressions, micro-momentary expressions, deception detection, emotional deception, facial expressions, emotional expressions,* and *universal expressions.*

The date range of 1966 to 2017 was used for the search. I used this quite extensive range because I believed that there was a limited amount of research that had been conducted on micro-expressions, which proved to be true. The search yielded a total

of 76 relevant articles, including seminal works as well as the current literature on micro-expressions. I compared these findings to reference lists of current (2012-2016) peer-reviewed articles on micro-expressions. The review of recent peer-reviewed articles resulted in seven additional articles and one additional book to review for this study.

Theoretical Foundations

The theoretical basis of this study was Darwin's (1872) theory of the universality of emotional expression, initially developed in his book *The Expressions of the Emotions in Man and Animals*. In this work, Darwin reported that in his observations, he had noted that both humans and many animals display the same facial expressions when reacting to certain stimuli. These findings led Darwin to posit that emotional displays were universal in humans as well as in each animal species. Though the belief that all emotional displays are universal in humans were not supported (Matsumoto, 1992; Waller, Cray & Burrows, 2008), it has been shown that at least seven emotional displays are shown universally in humans (Ekman & Keltner, 1970; Matsumoto, 1992; Waller et al., 2008).

When developing the theoretical foundation, I also drew on the work of Haggard and Isaacs (1966), Ekman and Friesen (1969), Matsumoto and Hwang, (2011), Yan et al. (2013), Shen, Wu, and Fu, (2012), and Kane and O'Byrne (2014). Haggard and Isaacs (1966) were the first to publish on the subject of micro-expressions, while Ekman and Friesen (1969) were the first to create a working theoretical model and explanation for the creation and displays of micro-expressions. Haggard and Isaacs (1966), and Ekman and Friesen (1969) showed that micro-expressions portray the universal emotions, and that they are created in high stress situations where an individual is concealing their true

emotional state. These findings would later be expanded upon by Rinn (1984) to include a neurological explanation of micro-expressions as a neurological battle for dominance of the facial muscles when a felt emotion is being concealed in a high stress situation. The battle for control of the facial display takes place between the aspects of the brain which control voluntary muscle movement, the prymidal track, and those that control involuntary movements, the extra-prymidal track. Matsumoto and Hwang (2011) were the first to show that it is possible to train individuals in micro-expression recognition, having their study participants retain the knowledge and be able to apply it at a later time in accordance with educational theory (Matsumoto & Hwang, 2011).

Yan et al. (2013) provided a current understanding of how micro-expressions are displayed, while Shen et al. (2012) provided an understanding of how individuals are able to recognize micro-expressions displayed using the theoretical model established by Ekman and Friesen (1969). Shen et al. indicated that a total displays time of or over 200 milliseconds for emotional facial displays is able to be accurately recognized by individuals. Finally, Kane and O'Byrne (2014) showed that it is possible to train individuals to recognize micro-expressions displayed in a manner consistent with Yan et al. (2013) findings and with the training method of Matsumoto and Hwang (2011).

Because micro-expression training uses the seven universal emotional displays, the aforementioned theoretical basis, as developed by Darwin and narrowed and formalized by Ekman and Keltner (1970), Matsumoto (1992), and Waller et al. (2008), was appropriate for this study.

Literature Review Related to Key Variables

The Universality of Emotional Displays

The seven universal emotions, anger, contempt, disgust, fear, happiness, sadness and surprise, are the basis for micro-expressions and thus key to this study. Studies (Boucher & Carlson, 1980; Ekman et al., 1972; Izard, 1971; Matsumoto, 1992) have shown that humans facially express at least seven different emotional states in the same manner across all races, genders, ethnicities, and creeds because of primary facial muscles in all humans which are responsible for expressing these emotions in the same manner. The expression of these emotions can be altered or prevented by medical conditions, such as spinal cord injuries and muscular atrophy as well as cosmetic interventions such as Botox injections (Waller et al., 2008).

The theory of the universality of emotional display was developed by Darwin (1872) and published in *The Expressions of the Emotions in Man and Animals*. In this work, Darwin stated his belief that emotional displays were universal in humans and in each species of animal due to evolutionary aspects that led to a common system of non-verbal communication. In a series of studies, Ekman and Keltner (1970) attempted to understand how emotional displays were identified in multiple cultural settings. Ekman and Keltner began by employing Darwin's method of showing individuals from a variety of cultures pictures of emotional displays of individuals from multiple races and having the participants identify which emotion they believed was being expressed. Ekman and Keltner culminated the study by using the recently discovered and previously isolated Fore linguistic group of South Highlands of New Guinea as participants. Ekman and

Keltner videotaped participants from this isolated group and then showed their emotional displays to college students in the United States. The final portion of this study involved videotaping university students without their knowledge while they watched both neutral and stress inducing material (graphic videos of surgeries) in Japan and the United States, and then showing the obtained videos to the alternate group and having them identify the expressed emotion.

In their analysis of the three conditions of the study, Ekman and Keltner (1970) found that emotional recognition was accurate at a rate of .88, far exceeding chance given that a total of seven emotional states were provided as potential answers. Their findings were in line with those of Darwin (1872). Though this study did not itself provide conclusive evidence of the universality of facial displays of emotions, it was the seminal works within the field.

Ekman and Keltner's work led to the development of the FACS by Ekman, Friesen and Hager originally published in 1978 with the second edition published in 2002. FACS is a coding method for facial muscle movements with each Action Unit (AU) given a numerical and alphabetical designator. The numerical designator indicates the muscular movement while the letter designator indicates the intensity of the movement on a 7-point Likert scale with "A" being barely noticeable movement and "G" being the largest physiologically possible movement. FACS has remained the primary method for coding facial muscular movements in the field of emotional deception detection and emotional identification (Yan et al., 2013). Despite the fact that FACS is based on peer-reviewed publications such as Ekman (1977b) who published a partial

peer-reviewed facial coding system, this facial coding system has not been subject to peer review and is not fully empirically supported.

Several researchers conducted a series of studies that replicated the Ekman and Keltner (1970) findings. These included the work of Boucher and Carlson (1980), Ekman et al. (1972), Galati, Scherer, and Ricci-Bitti (1997), Izard (1971), Matsumoto (1992), Yan et al. (2013), and Shen et al. (2012). Of these, Boucher and Carlson, Ekman et al., Izard, and Matsumoto studied in depth emotional displays in cross-cultural settings and obtained statistical findings similar to Ekman and Keltner's findings.

Additional studies contributed to the understanding of the universality of facial displays of emotion. Notable is the Galati et al. (1997) study examining if differences existed in emotional displays between congenitally blind children and their normally sighted counterparts. Coding of facial displays of the universal emotions between the two groups showed no difference at a level of statistical significance for intensity of emotional display between the groups, though the exact statistical findings were not presented in the study. The study showed that when individuals were asked to portray an emotional state through a facial expression of emotion and they were not experiencing the emotion, there were large differences between blind and sighted individuals in the facial displays. Galati et al. (1997) found that when the emotional states were being felt by the individuals, there were similar facial expressions beyond that of chance and were accurately recognized by judges for both blind and normatively sighted individuals ($p < .01$).

Though a number of issues exist with the Galati et al. (1997) study, notably the absence of the specific statistical results when the null hypothesis was accepted, the study has served as a seminal work within modern facial expression coding and added to the current understanding of the universality of emotional display as the results indicated that there is an instinctual aspect in emotional display due to the lack of coding differences in congenitally blind and normatively sighted individuals facial expressions of anger, contempt, disgust, fear, happiness, sadness, and surprise. Since the publication of the Galati et al. study, the results have been replicated in numerous studies. Notable replication of the Galati et al. findings are seen in a meta-analysis of the available data by Elfenbein and Nalini (2002) who found that there was no significant difference between cultural, blind, gender, and regional groups' emotional displays of anger, contempt, disgust, fear, happiness, sadness, and surprise when the emotional states were felt or were properly imitated ($t(161) = 37.6$, $p < 10^{-14}$, one-tailed, $r = .95$). An in-group advantage in emotional recognition was present in the findings ($p < .02$), with this finding believed to be due to facial muscular differences between ethnic groups in secondary facial muscles.

What are Micro-Expressions?

Micro-expression research began in the 1960s when Haggard and Isaacs (1966) were analyzing video recordings of therapy sessions frame by frame conducting an analysis of nonverbal cues that were presented in the session between the patient and psychologist. During this analysis it was noted that there were brief facial emotional displays that were otherwise unable to be seen. These facial expressions were named "micromomentary facial expressions" by Haggard and Isaacs, and led to additional

research on these brief facial expressions. These brief facial expressions were also noted in a study on marital non-verbal communication interactions, which analyzed videos of spousal interactions on a frame by frame basis where each frame was 1/25 of a second (Condon & Ogston, 1966). The Condon and Ogston (1966) research provided further naturalistic observations on the existence of what would become known as micro-expressions.

A series of studies conducted by Ekman and Friesen (1969; 1974) renamed the emotional displays to micro-expressions and showed in what circumstances micro-expressions were shown. In the first study, Ekman and Friesen (1969) conducted two case studies in which they videotaped and then analyzed therapy sessions of two patients to identify micro-expressions and other deceptive behaviors. The videos were shown to 32 and 28 individuals for study 1 and 2 respectively to code for deceptive behavior. The coders observed micro-expressions in both videos when the films were shown in slow motion depicting sadness while the therapy patient stated that they were not experiencing this emotional state.

Though the Ekman and Friesen (1969) study provided a more comprehensive understanding of micro-expressions and other deceptive indicators from naturalistic observations, the study utilized only two video recordings while a total of 120 recordings of 40 inpatient individuals had been obtained, as micro-expressions were only present in two videos. Utilizing the additional videos would have provided an increased level of evidence within the study. Further, the only statistical report within the study was the interrater reliability for each deceptive indicator. As the study was based in naturalistic

observation, the reporting of frequency of each deceptive indicator would have added to the overall understanding of the phenomenon. Despite these limitations, this work is often stated as a seminal work in micro-expression identification (Boucher & Carlson, 1980; Ekman et al., 1972; Izard, 1971; Kane & O'Byrne, 2014; Matsumoto, 1992; Matsumoto & Hwang, 2011; Porter, ten Brinke & Wallace, 2012; Shen et al., 2012; Yan et al., 2013).

Ekman and Friesen (1969) research was followed by a study (Ekman & Friesen, 1974) on general deception detection practices in which nursing students were shown a series of videos, one video of a nature setting to calm them and the alternate video was of graphic surgeries. At the same time they would have to describe a pleasant scenario and convince the interviewer that this description was of the video they were watching regardless of which video was being shown. The interviewer was unable to see the video and the interactions were recorded. The nursing students were told that successfully deceiving the interviewer was key to their program completion in an attempt to elicit a high stress state. The removal of nurses from their program of study if they were unable to conceal their emotions was stated to be a deception after the completion of the study to the participants.

After the completion of the study four experienced facial action coders analyzed the videos in slow motion and identified micro-expressions in the majority of deceptive videos (Ekman & Friesen, 1974). Further information on the prevalence of micro-expressions was not presented in the study leaving the reader to question the finding of micro-expressions within the study.

The work of Ekman and Friesen (1974) was followed by Ekman and Friesen (1977) publishing a meta-analysis of their work where an in-depth understanding of micro-expressions displays began to form. The meta-analysis suggested that micro-expressions are shown in a pattern of brief facial expressions lasting for less than half a second and shown during emotional concealment in a high stress situation.

Since Ekman and Friesen (1977) published their meta-analysis little work has been done on micro-expressions. The minimal research on micro-expressions since the Ekman and Friesen (1977) study has led to little empirical evidence of micro-expressions in the modern literature as the majority of research conducted after 1977 has been on the ability to detect lies (Porter & ten Brinke, 2008; Porter et al., 2010). Research into micro-expressions noticeably increased after 9/11 with numerous studies being published in the following years (Porter & ten Brinke, 2008; 2010; Porter et al., 2010) in which micro-expression displays were examined. In the first of these studies, Porter and ten Brinke (2008) attempted to elicit micro-expression reactions from undergraduate students (N=41) by exposing them to a variety of images from the International Affective Picture System (IAPS), a normed emotional elicitation database, attempting to elicit an emotional response of disgust, sadness, fear, happiness, or no emotional response. Participants were shown a set of photos and asked to portray the same emotion each time they saw a photo, and this procedure was repeated for each emotional state which was attempting to be elicited. As a result there were three potential types of facial expressions which could be displayed. The first is the true emotional state, that being the students saw a photograph which made them sad (or any emotional reaction which the photo set was attempting to

elicit (sadness is used as an example here). They were asked to express a sad facial expression, a masked facial expression in which the photo did not make them sad though elicited another emotional reaction and they showed sadness, and finally a simulated facial expression in which the photo elicited no emotional reaction though a sad expression was shown.

The study (Porter & ten Brinke, 2008) videotaped, at a rate of 30 frames per second, the participants as they viewed the pictures on a computer screen with each emotional elicitation set containing 3 images with a total of 17 images being shown including five images which were meant to not elicit any emotional response. The results were then analyzed frame by frame for micro-expressions by the two authors who had extensive experience in the facial coding of expressions (Porter & ten Brinke, 2008). In total, 104,550 frames were analyzed for micro-expressions with an interrater reliability of .933 for facial movements. The study found that all participants expressed micro-expressions though the expressions were not consistent with the definition of micro-expressions at the time. The inconsistency with the definition of micro-expressions was due to the micro-expressions lasting longer than 200 milliseconds, and only appearing in the upper or lower potations of the face, while no full facial micro-expressions were identified. The study did not indicate the range of time in which micro-expressions were displayed for, and noted that the participants were not in a high stress situation as they were participating for extra-credit in an undergraduate psychology class. The authors noted that the theoretical foundation for micro-expression requires a high stress

emotional deceptive situation and this may have impacted the displays of the micro-expressions.

The study (Porter & ten Brinke, 2008) produced two primary results. The first was that partial micro-expression occurred during masked or simulated facial expressions and always corresponded with the emotion which the shown picture attempted to elicit, $F(6, 35) = 17.33$, $p < .001$. The second was that despite not creating an environment where the participants felt high levels of stress in concealing their true emotional state, the study provided the first evidence of micro-expression displays since 1977.

The Porter and ten Brinke (2008) study was followed by research conducted by the same authors in which they attempted to further understand how and why micro-expressions are displayed (Porter et al., 2010). The Porter et al. study replicated the Porter and ten Brinke (2008) study in the use of the IAPS photographs, recording of individuals utilizing a video camera at a rate of 30 frames per second, with the alteration of a wide screen 27 inch LCD monitor, over a 17 inch CRT monitor that had been utilized in the previous study. The study utilized 59 undergraduate participants, and utilized the same procedure from the Porter and ten Brinke (2008) study for emotional displays, requesting all participants to show certain emotions for each photo set resulting in true, simulated and masked emotional displays. The images which were shown in these photo sets had a greater valence to elicit a greater range of felt emotions (Porter et al., 2010).

The Porter et al. (2010) study resulted in a total of 256,650 frames of video which were analyzed by the authors with each frame being coded twice, once for upper facial movement and once for lower facial movements. The authors of the study underwent

extensive training in emotional recognition prior to the commencement of the study resulting in a high level of interrater reliability between the three authors, $p < .001$, 87.3% agreement.

The study (Porter et al., 2010) found that there was a significant effect for micro-expressions lasting for less than half a second, $F(6,53) = 28.28$, $p < .01$. Fear was the most commonly seen micro-expression, while happiness was the least. The study also found that micro-expressions were more likely to take place when photos which elicited a high emotional response versus a low emotional response were shown, $F(1,58) = 3.34$, $p =. 07$.

Though a number of micro-expressions were seen, none met the definition at the time of micro-expressions, lasting less than 200 milliseconds, in the study (Porter et al., 2010). No micro-expressions appearing was stated in the discussion to potentially be due to the low stakes of the experiment, in which there was no negative consequences, perceived or real, for participants if they were unable to conceal their true emotional state.

Though these studies (Porter & ten Brinke, 2008; Porter et al., 2010) found that micro-expressions are shown in low stakes environments, and last longer than the 200 millisecond emotional displays for micro-expressions theorized by Ekman and Friesen (1974), no full facial micro-expressions were shown. Arguably this is due to the low stakes and thus low stress environment of the study, as there are ethical issues with creating a high stress environment for participants, restricting the studies abilities.

However these findings provide additional evidence for the existence of micro-expressions.

The final study that provided evidence of what micro-expression are was conducted by Yan et al. (2013). Yan et al. found that micro-expressions are not displayed in the manner in which previous research had theorized. Yan et al. found that micro-expressions are displayed in a positively skewed curve to reach the highest intensity of the emotional display. The Yan et al. research showed that the highest intensity of the emotional display is reached approximately 1/3 of the way through the displays of the micro-expressions. It was also found that the highest intensity of the emotional display is displayed for a shorter duration than previous researchers had hypothesized, 17 milliseconds on average versus 200 milliseconds, respectively.

Yan et al. (2013) reproduced the Ekman and Friesen (1974) study, in which individuals were shown a video and were told to maintain a neutral or happy expression, though for ethical reasons, stated that for each emotional display shown by the participants 5 Chinese Yuan would be deducted from the participation incentive where the Ekman and Friesen stated to students that if emotional leakage was detected the participants would be removed from their nursing program. In the Yan et al. (2013) study the participants, undergraduate students at a Chinese university, were seated in front of a 19 inch computer monitor with a video camera recording that at a rate of 60 frames per second. Then, 17 videos were shown in a randomized order to the participants with the videos attempting to elicit a strong emotional reaction. After each video the participant was asked to state the emotion they believed the video was attempting to elicit.

The videos were then coded by two individuals identifying emotional expressions which lasted for or less than 500 millisecond or 30 frames. In total 245 emotional expressions lasting for less than 1 second were observed with 109 facial expressions lasting less than half a second being observed. The mean duration of the 109 observed facial expressions was 313.91 millisecond ($p < .05$, SD = 85.81, range 166.67 to 502.78), with a mean onset duration of 139.91 milliseconds ($p < .05$, SD = 50.05, range 65.97 to 261.93). The study identified 15 instances of micro-expressions lasting less than 200 milliseconds which was the theoretical framework for micro-expression displays developed by Ekman and Friesen (1974). The differences in definitions was discussed and as the micro-expressions presented themselves in the same manner of intensity onset between the two groups (less than 200 and 500 milliseconds) it was argued that an increase in technological capabilities allowing for increased frame rate and detail to be seen in videos allowed for the increased analysis and understanding of micro-expressions. Within the discussion it was stated that there currently does not exist a commonly accepted definition of micro-expressions. As the 200 millisecond definition was developed during the seminal work research, and this is in contrast to current researching showing that micro-expressions last longer than 200 milliseconds (Porter & ten Brinke, 2008; 2012; Porter el al., 2010; Yan et al., 2013). As such, the study (Porter el al., 2010) utilized a definition of micro-expressions as facial expressions lasting less than 500 milliseconds.

Why do Micro-Expressions Appear?

No studies have been completed on the neurological rational for why micro-expressions appear. A single paper has been written on the subject providing a theoretical understanding of the neurological rational for micro-expressions. Rinn (1984) wrote on the neuro-biological rational for voluntary and involuntary facial movements including micro-expressions as an involuntary facial movement. In this paper Rinn discussed the roles which the prymidal and extraprymidal tracts of the brain impact voluntary and involuntary movement. Rinn stated that the prymidal tract controls voluntary movement while the extraprymidal tract controls involuntary movement. In high stress circumstances when an individual is feeling one emotion and displaying an alternate emotional state through their facial expression, both the prymidal and extraprymidal tracts of the brain seek to control the facial expression. While the prymidal tract will control the facial emotional display the extraprymidal tract will attempt to gain control and show the true emotional state the individual is experiencing. The battle for facial display dominance between the prymidal and extraprymidal tracts was theorized to be the neurological rational for the displays of micro-expressions.

Rinn (1984) also addressed the neurological differences between the upper and lower face, focusing on the extraprymidal tract role in upper facial movements. The differences in upper and lower facial displays as controlled by the extraprymidal track is supported by findings from Porter and ten Brinke (2008) as previously discussed. Further discussion on the role of instinctual facial displays are briefly mentioned in the context of

emotional displays of blind individuals strengthening the theoretical foundation for the universality of emotional displays (Rinn, 1984).

The point that increased cognitive stress only appears in deceitful circumstances was argued against by Gombos (2006). The article which argued that increased cognitive load may be present in truthful settings due to the complexity of recalling specific details of an event. Arguably this could lead to the displays of micro-expressions if multiple emotional states were being felt by the individual. Gombos theory of micro-expression displays rational has not been followed up since its publication in 2006.

Ability to Recognize Micro-Expressions

Few studies have specifically looked at the physiological and cognitive abilities to properly recognize micro-expressions. To date only one such study has been identified, as published by Shen et al. (2012). The study investigated the effects of duration of micro-expressions on the proper identification of micro-expression emotional displays: this was completed in two separate experiments. The first experiment utilized two micro-expression training methods to determine if any difference in training outcome exists in six of the seven universal emotions (anger, disgust, fear, happiness, sadness, and surprise. The rational for the exclusion of the contempt expression was not stated. Two programs were used, these are the Brief Affect Recognition Test (BART) and the Micro-Expression Training Tool (METT). In the BART a cross is shown on the screen for one second which was immediately followed by one of the emotional displays, while in the METT a neutral face shown for two seconds precedes and followed the emotional depiction and utilized 11 participants all of whom reported normal vision (Shen et al., 2012). The

training methods of the METT were not utilized and instead all participants were shown how to accurately identify the six emotional states through researcher instruction, while the METT micro-expression recognition test was utilized. In both programs the exposure to the emotional picture was 40, 120, 200 or 300 milliseconds.

The results were analyzed in a repeated measures ANOVA in a 2 (condition) by 4 (duration) by 6 (emotional display) analysis. The main interaction of condition was not significant, $F(1, 10) = 0.962$, $p = .350$, though there was a significant effect for duration $F(3,30) = 109.027$, $p < .001$. The ability to properly recognize the emotional display increased as the exposure time increased in both the BART and the METT, though the BART had a higher accuracy rate than the METT at the 40 millisecond display at approximately .65 and .5 respectively

In the second experiment (Shen et al., 2012) 12 individuals participated and all reported normal vision. The second experiment sought to understand how much training was required to properly identify the six emotional states utilizes in the first experiment shown as micro-expressions at durations of 20, 40, 80, 120, 160, 200, and 280 milliseconds for both the BART and METT methods of micro-expression displays.

The results (Shen et al., 2012) were analyzed in a repeated measures ANOVA in a 2 (condition) by 8 (duration) by 6 (emotional display) analysis. There were significant interactions for condition, $F(1, 11) = 51.932$, $p < .001$, duration, $F(7, 77) = 104.416$, $p < .001$, and expression type, $F(5, 55) = 13.022$, $p < .001$. The findings also showed that there were no significant differences between the training methods at a duration of 160 milliseconds and greater, $p > .455$.

Overall, the study (Shen et al., 2012) found that training allowed individuals to recognize micro-expressions with accuracy at durations of 20 milliseconds with increasing in ability as exposure increased plateauing at 200 milliseconds. Further the expressions of surprise, and happiness, in that order, were the easiest to recognize with fear being the hardest. The obtained results on emotional recognition as micro-expressions coincides with results obtained by McAndrew (1986) in emotional identification of the universal emotions. Further the experiment did not utilize emotional displays beyond 300 milliseconds as the original theoretical framework of micro-expression displays stated that micro-expressions were displayed between 40 milliseconds and 200 milliseconds (Ekman & Friesen, 1975; Shen et al., 2012), later statements by Ekman (2009) altered his definition of what a micro-expression is to stated that micro-expressions were any facial expression lasting less than 500 milliseconds (Ekman, 2001).

Overall, Shen et al. (2012) noted that the accuracy of micro-expression identification was higher than in other studies and it was stated that this could be due to the use of only two models for emotional expression, one of each sex, with higher scores being obtained due to testing effect. It was also noted that the lower scores obtained from participants utilizing the METT may be a result of the neutral face which preceded the micro-expression displays. The METT simulates micro-expression displays in naturally occurring instances over the BART testing method providing increased external validity to these findings.

The study shows that it is physiological possible to accurately recognize micro-expressions at a multitude of durations and determine which emotional was being expressed, which had previously not been shown.

Training to Recognize Micro-Expressions

Micro-expression training is limited to the seven universal emotional expressions to exclude cultural difference in non-verbal communication within the training (Ekman, 1977a). The seven universal facial expressions comprise the seven emotional states of anger, contempt, disgust, fear, happiness, sadness, and surprise (Boucher & Carlson, 1980; Ekman & Keltner, 1970; Ekman et al., 1972; Izard, 1971; Matsumoto, 1992).

To date only two studies (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011) have been conducted on training outcomes of micro-expression training methods, with a third study on training outcomes comparison between two groups. The first of these studies was conducted by Matsumoto and Hwang (2011). This study utilized two separate training groups to determine if individuals can be trained to recognize micro-expressions. The micro-expression training tool was created by the authors and had an inter-rater reliability of .86 for coding requirements of each emotional display. The training tool utilized in both studies showed micro-expressions displayed for 200 milliseconds preceded and followed by two seconds of a neutral face of the same individuals who is shown displaying the micro-expressions. The micro-expression was shown as a still photo of the highest intensity of the emotional display displayed by the individual.

The first training group was 81 Korean individuals who were recruited from a retail store chain in South Korea (32 males, 48 females, 1 declined to answer; mean age =

30.30 years, SD = 8.12). From an educational perspective the group was diverse with 39 having high school diplomas, 29 having completed a two year college degree, and 9 having completed a 4 year university program.

The participants completed a micro-expression training program, which included a pre and post-test of micro-expression recognition ability for both the training and the control group. In providing a pre-test to the participants each universal emotional display shown as a micro-expression was shown twice. As the study utilized a control group this part of the study would have greater external validity as the testing effect may have impacted the outcome of the post-test results for the control group, and in the use of a control group a pre-test is not required (Tabachnick & Fidell, 2007). The results were analysed utilizing a two-way ANOVA, using condition and time (pre and post-test) as the analysis variables. The findings were significant $F(1,72) = 10.90$, $p < .01$. The analysis found that scores increased for the training group between pre and post-test though did not increase for the control group, $p < .89$ (Matsumoto & Hwang, 2011).

In the second study, 25 trial consultants (11 male, 14 female, mean age = 46.31 years) were utilized as the experimental groups and 30 individual (13 males, 17 females, mean age = 49.83) were recruited through the snowball method were utilized as the control group. The study employed the same experimental method as the previous study. The main effect of time was significant, $F(1, 22) = 32.30$, $p < .01$, as was the emotional recognition of anger, contempt, disgust, fear.

Both studies were followed up three weeks later and re-administered the micro-expression post-test to all four groups in an attempt to understand if the ability to

recognize micro-expressions after training is retained. The findings were significant, $F(1, 41) = 17.90$, $p < .01$, between the training and comparison groups. Overall the results were promising as the participant's ability to properly recognize micro-expressions three weeks after their training was initially conducted was in line with educational knowledge loss understanding (Ebbinghaus, 1992; Matsumoto & Hwang, 2011).

Matsumoto and Hwang (2011) were the first researchers to test if micro-expression recognition was a trainable and retainable skill and their work suggested that it is. Despite this work being the seminal work in micro-expression training, some flaws within the study have been previously noted in this paper. The work of Matsumoto and Hwang (2011) was built upon by Kane and O'Byrne (2014) and addressed micro-expression training given the new understanding of micro-expression displays as shown by Yan et al. (2013).

In their study, Kane and O'Byrne (2014) conducted a three hour training session on micro-expressions in a second year class at the University of New Brunswick's Law School. In total, 42 individuals participated in the study over two instructional periods.

Participants were provided instruction on micro-expression recognition in the same manner as the Matsumoto and Hwang (2011) study, with the addition of instruction from multiple viewing angles on the Y-axis (0, 45, and 90 degrees; head on, at an angle and profile, respectively) with the aim of providing a great level of ability to recognize micro-expressions from positions other than head on and incorporated the Yan et al. (2013) findings on how micro-expressions are displayed naturally. The emotional

displays via micro-expression had an inter-rater reliability of .83 when coded in accordance with the FACS (Kane & O'Byrne, 2014).

Participants were provided with a pre-test consisting on 42 videos of micro-expression displays of the seven universal emotions with each emotion being shown two times from each of the three angles (Kane & O'Byrne, 2014). Training was then provided in class over a 90 minute period and then continued two days later culminating in a post-test provided in the same format as the pre-test utilizing micro-expression displays from alternate actors to minimize testing effect.

A number of factors precluded the use of all participants in a statistical analysis (2 for previous training, 5 answered only 1 test, 3 answered 50% or less of questions on one test) leaving a total of 32 participants for statistical analysis. The study utilised a two-sample T-test utilizing the two testing times to compare means. The study found that post test results were statistically significant in improvement in ability to recognize micro-expressions over the pre-test, $t(31) = 8.193$, $p < .001$, Cohen's d = 2.179 (Kane & O'Byrne, 2014).

The study had a number of issues that may have effected post-test scores. The largest of these is the period over which training took place, allowing for participants to obtain additional information on micro-expressions outside of the instructional setting. The authors noted this as an issue within the study and stated that this was due to the time required to complete the training and the inability to schedule a three hour training session within the law school due to class schedules. Further the participants reported in a post-test qualitative survey that the method which was utilized for obtaining results,

Socrative software, was difficult to utilize and at times confusing, with two individuals stating that they ceased answering due to these complications. Finally the sample size was small and a larger sample size would help ensure the generalizability of the results (Kane & O'Byrne, 2014).

The Kane and O'Byrne (2014) study, despite its shortcomings, provided evidence that micro-expression training can be successfully completed utilizing the method of emotional display for micro-expressions as outlined in Yan et al. (2013), as well as supporting the findings from Matsumoto and Hwang (2011) showing that micro-expression recognition is a trainable skill, and is supported by the Shen et al. (2012) study as previously discussed.

An additional study test (Hurley, Anker, Frank, Matsumoto, & Hwang, 2014) sought to address differences in training outcomes between undergraduate and security guards. The study utilized the micro-expression training method used in the Matsumoto and Hwang (2011) study. The study compared pre and post test scores on micro-expression recognition between the two groups, undergraduate students (n = 356) and TSA Behavior Detection Officers (BDO) (n = 127). All participants undertook micro-expression recognition training and conducted a pre and post-training micro-expression recognition.

The authors utilized a multiple regression to understand if any covariates impacted micro-expression recognition at either the pre or post-test levels. Age was a major predictor of score ($\beta = -.24$, $p = .011$), and having no law enforcement experience

($\beta = 0.21$, $p = .020$) was a predictor for BDO micro-expression identification (Hurley et al., 2014).

Summary and Conclusions

The preceding chapter reviewed the literature on the subject of micro-expressions and the universality of specific emotional displays. It was noted throughout the chapter that currently there is an extremely limited body of knowledge on micro-expressions. Due to this there is limited replication of studies within this field which has led to validity questions on the subjects of micro-expressions and the universality of emotional displays. Despite the above stated issues with the current body of research on micro-expressions those studies that have been replicated have come to similar conclusions.

It is currently understood that there exist facial displays that portray seven different emotional states in the same manner across all of humanity. These emotional facial displays are anger, contempt, disgust, fear, happiness, sadness, and surprise (Boucher & Carlson, 1980; Ekman & Keltner, 1970; Ekman et al., 1972; Haggard & Isaacs, 1966; Hill, 2003; Izard, 1971; Matsumoto, 1992).

It has also been shown that these emotional displays are shown in micro-expressions, brief facial expressions that last for less than half a second (Ekman, 2001; Yan et al., 2013) and show the universal facial expressions (Boucher & Carlson, 1980; Ekman & Keltner, 1970; Ekman et al., 1972; Haggard & Isaacs, 1966; Hill, 2003). It has also been shown that it is possible to train individuals to properly recognize micro-expressions under different settings (Kane & O'Byrne, 2014; Matsumoto & Hwang,

2011). These three areas of knowledge allow for a comparison of the picture-based and video-based micro-expression training methods.

The purpose of the current study was to quantitatively investigate the differences, if any, between the post training accuracy rates of overall and emotion specific micro-expression identification outcomes of the two current micro-expression training methods and no training in micro-expression recognition. This study fills a primary gap in the literature, as there has previously been no comparison of these training methods.

In Chapter 3, the rationale and methodological design for the study are discussed. Chapter 3 includes an overview of the population studied, sampling and recruitment methods, and data collection procedures. The data analysis plan is outlined along with the justification for the analysis methods. Chapter 3 culminates in a discussion on the ethical considerations of the study and safeguards from undue harm.

Chapter 3: Research Method

There are two training methods used to train individuals to properly identify micro-expressions. The first of these methods uses pictures (Matsumoto & Hwang, 2011) to provide the training while the second method uses videos (Kane & O'Byrne, 2014). I conducted this study to determine if differences exist in participants' abilities to recognize micro-expressions between the two training methods and no training.

In this chapter, I provide a detailed overview of the sample, sampling methods, recruitment methods, data collection, and instrumentation. The chapter concludes with a discussion of threats to internal and external validity and ethical concerns associated with micro-expression training.

Research Design and Rationale

In this study, I used a quantitative experimental post-test only control group design to test if any differences exist between the post training accuracy rates of overall and emotion-specific micro-expression identification outcomes of the two current micro-expression training methods and no training. The participants received training in micro-expression recognition via a web-based training platform. Each of the participants was provided with a uniform resource locator (URL), which randomly assigned them to one of the three conditions. The participants completed a consent form prior to beginning the micro-expression training.

The online training was designed such that the participants were instructed on how to properly recognize each emotional display individually as well as when compared to similar emotional displays. Training and data collection were completed in

approximately 30 to 45 minutes. After completion of the training, participants assigned to the picture-based training group and the video-based training group completed a 42-item micro-expression test in which they were shown the seven universal emotional expressions, with each expression shown six separate times displayed as micro-expressions in accordance with the Yan et al. (2013) findings. Participants assigned to the untrained (no training) group completed the post-test and were then provided the opportunity to complete the micro-expression training of their choice in accordance with ethical principles of research (Gibbon, 2002).

The participant population was drawn from MTurk. The use of web-based training allowed for increased data collection given the geographic area in which the population of the United States reside. Further, online training provided consistent training to all participants in each group.

Previous studies (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011) of micro-expression training methods have used a pre-test post-test design to determine differences in ability to recognize micro-expressions due to the independent variable of training. The use of a quasi-experimental design in these studies given the brief period under which micro-expression training is primarily taken, 30 to 45 minutes, may result in issues of external validity due to the interaction effects of testing. Due to this potential validity issue, I used a three-group post-test-only control group design. The three group post-test-only control group design allowed for a comparison of the training methods against each other as well as the no training group, allowing for an understanding of any difference between the experimental groups as well against the no training group. The three-group

post-test-only control group design allows for a more comprehensive understanding of the overall training outcome.

Methodology

Population

In this study, I recruited participants from MTurk. MTurk is an online worldwide-based data collection system that allows population criteria to be selected for participants (Amazon, 2017). Recruiting participants from MTurk allowed me to obtain a convenience sample. The primary limiting factors for this approach were availability of a computer with access to internet, time to participate, Amazon and MTurk accounts, detection of the study once posted, acceptance of the monetary compensation, and fluency in English.

Sampling and Sampling Procedures

The purpose of the study was to quantitatively investigate the differences, if any, between the post training accuracy rates of overall and emotion specific micro-expression identification outcomes of the two current micro-expression training methods and untrained individuals in the sample population. The purpose lent itself to a randomized assignment method for the study. Participants were randomly assigned to one of the three conditions in the experiment to ensure that, prior to treatment, there was an equal probability of inclusion in each of the conditions (see Frankfort-Nachmias & Nachmias, 2008).

Sampling Frame

The individuals whom a researcher wishes to use as participants must be properly stated as a lack of such statement limits the reproducibility of the study and threatens the external validity of the study. Clearly stating the participant population assists in developing eligibility criteria for the study (Frankfort-Nachmias & Nachmias, 2008). Inclusion in the study was set as members of the MTurk community who reside within the United States, are fluent in English, and are 18 years of age and older.

Sample size and power analysis. A power analysis using G*Power 3.1.9.2 (Faul et al., 2009) was conducted to determine the appropriate sample size using a repeated measures, between interaction ANOVA, with an effect size of .5 and an α error probability of .05. The G*Power analysis resulted in a total sample size of 192, 64 participants for each of the three conditions. Obtaining the appropriate statistical power is fundamental in decreasing the probability of a Type II error in the study that being the acceptance of the alternate hypothesis when the null hypotheses should be accepted (Tabachnick & Fidell, 2007). Further, within research, power is an essential analytical aspect in order to obtain valid inferences of the findings and is dependent upon the factors of significance, sample size, and effect size (Tabachnick & Fidell, 2007). Hsu (1988) stated the importance of ensuring that the sample size conformed to all necessary parameters of the study while also ensuring high probability values. The study obtained a sample size of 195 participants, 64 in the video-based training condition, 67 in the picture-based training condition, and 64 in the no training condition.

Procedure for Recruitment, Participation, and Data Collection

Recruitment procedures. Participants were recruited through MTurk. MTurk is an online data collection community in which participants can be paid to participate in research projects and testing (Amazon, 2017). I placed a brief statement about the study on MTurk requesting participants along with notice of the compensation amount of $3.00 per participant. Participants who did not complete the training and the post-test did not receive compensation for their time. Participants were paid through the MTurk payment system. Participants in the MTurk participant pool were able to read the study's recruitment statement, including the Walden Uiniversity IRB approval number (11-01-17-0591787), and select if they wished to participate in the study. When individuals selected to participate, they were directed to one of the three conditions through a random link assigning code within the host site's HTML. Participants then completed the training and post-test, if assigned to one of the two training groups, or the post-test and then the option of completing the training, if assigned to the no training group. Once each group had 64 participants who had completed the training and post-test, I removed the request for participants from MTurk, thereby ending the recruitment process.

Provisions of informed consent. The informed consent procedure provided an overview of the benefits and risks of participating in the study comparing micro-expression training methods. When the participants accessed the online training via the provided URL, they were directed to the informed consent webpage. Once the participants had reviewed the consent page, they were asked to either select a continue button to proceed to the study's materials or to close the webpage to exit.

In accordance with the American Psychological Association (APA) code of conduct (2010), the informed consent process requires statement of the purpose of the study, the length of participation, the individual's right to decline participation in the study and to withdraw from the study at any time, any potential consequences of withdrawing or declining to participate, risks, benefits and potential consequences of the study, limits of confidentiality, incentives to participate, and whom to contact about questions regarding the research and/or participants' rights. Participants were informed of their rights, who and how to contact in the event of questions, the nature, purpose, time commitment, risks and benefit, and the amount of compensation ($3.00) they would receive should they complete the study.

Mode of data collection. Participants selected the study from the list of available studies on MTurk. Upon selecting the study, participants were brought to an instruction page on Mturk that provided a basic overview of the study and a link bringing participants to the study landing page. On the landing page, participants were asked to read the consent form. After they read the consent form, they proceeded to the study if they selected the continue button and in doing so agreed to participate in the study. At this time, for the two experimental conditions, instruction on the characteristics of each of the seven universal emotions took place. The instruction was followed by a comparison of the anger and disgust facial expressions and the fear and surprise expressions because each set of expressions are displayed in a similar manner. For the video-based training group, this was done via videos showing the progression of both emotions simultaneously. For the picture-based training group, this was done via pictures of each

emotion shown at its highest intensity of the emotional display. In the picture-based training group, this presentation was followed by each of the seven universal emotions being displayed as a picture shown at the emotion's highest intensity, allowing the participant to better understand how the emotion is displayed. For the video-based training group, this presentation was done with a slow motion displays of the emotion from origin to conclusion. The no training group was provided with the option to complete the training after participants completed the post-test, if they desired to do so. After this stage, instruction was completed.

For the post-test, participants were shown a series of videos in which displays of the seven universal emotions were shown in accordance with the Yan et al. (2013) findings on how micro-expressions are displayed. In total, there were 42 videos each showing a micro-expression of one of the seven universal emotions. Each video lasted for 10.36 seconds with the initial 5 seconds being a display of a neutral face followed by the micro-expression displays lasting 360 milliseconds and followed by 5 seconds of neutral face. At this time, participants selected which of the seven emotional displays they believed was exhibited and then they clicked next to view the next video with the process taking place a total of 42 times. Responses were recorded by which emotion was selected, and the response was coded as either correct or incorrect and as a numerical indicator corresponding to the emotion. Once the testing was completed, the participant received their score and were again provided with my contact information should they have any concerns or questions. At this time, participants were asked to provide an email address

should they wish to receive the study findings, but no participants requested the studies findings.

Practical and technical consideration regarding the use of web training. Web-based instruction methods have been shown to be equally effective in providing instruction and knowledge outcomes as traditional classroom-based methods (Brown & Park, 2016; Kim, & Bonk, 2006). Individuals who are part of MTurk participant community are assumed to be familiar with online-based training because MTurk is an online training and data collection system.

Instrumentation

Micro-expression training has been conducted in the public domain since the early 1990's (Matsumoto & Hwang, 2011). Micro-expression training is based on the universality of emotional displays (Darwin, 1872; Ekman & Keltner, 1970). Micro-expressions appear as brief facial expressions when a false emotional state is being displayed in a high stress environment (Ekman & Friesen, 1969; Rinn 1984). There currently exist two training platforms which have been empirically supported in picture and video-based training methods, in 2011 and 2014, respectively (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011). The instrumentation that was utilized for this study is based on the Kane and O'Byrne (2014) training method. The Kane and O'Byrne (2014) training method utilized videos to train individuals to recognize micro-expressions.

The study utilized the instructional methods of the Kane and O'Byrne (2014) and Matsumoto and Hwang (2011) study, while utilizing the video-based training methods of the Kane and O'Byrne (2014) study. The video-based condition utilized the videos of this

method, while the picture-based condition utilized the same emotional displays depictions through picture-based training methods. Permission to utilize and alter the training material has been obtained from the primary author of the Kane and O'Byrne study.[1] Utilizing the training method and material from the Kane and O'Byrne (2014) study allowed for a comparison of the training methods to answer the research questions.

Operationalization of Constructs

Research conducted on the universality of emotions has shown that there exist a minimum of seven universal emotional displays which are displayed in the same manner across humanity regardless of race, religion, age, sex or other demographic differences with some exceptions, notably medical conditions which impair either facial muscular ability, or the cognitive ability to experience emotions (Boucher & Carlson, 1980; Ekman & Keltner, 1970; Ekman et al., 1972; Izard, 1971; Matsumoto, 1992). These emotions are anger, contempt, disgust, fear, happiness, sadness, and surprise. Micro-expressions are brief facial expressions that last for or less than half a second and show the seven universal emotions (Kane & O'Byrne, 2014; Yan et al., 2013).

Data Analysis

To investigate the inquiry, two research questions were used to determine if any difference between instructional methods was present.

Research Question 1: What is the difference in overall accuracy rate to detect micro-expressions between the picture-based training method, the video-based training method, and no training?

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[1] I was the primary author of the Kane and O'Byrne (2014) study.

$H_0$1: There is no significant mean difference in overall accuracy rate between the picture-based training method, the video-based training method, and no training.

$H_1$1: There is a significant mean difference in overall accuracy between the picture-based training method, the video-based training method, and no training.

Research Question 2: What is the difference in ability to recognize specific facial expressions within and between the picture-based training method, the video-based training method, and no training?

$H_0$2: There is no significant mean difference in ability to recognize specific facial expressions within and between the picture-based training method, the video-based training method, and no training.

$H_1$2: There is a significant mean difference in ability to recognize specific facial expressions within and between the picture-based training method, the video-based training method, and no training.

In order to analyze the data, IBM SPSS version 24.0 was utilized. To test the first hypothesis, a three-group one-way between groups ANOVA was conducted to assess differences in mean scores between the post training accuracy rates of overall micro-expression identification outcomes of the two current micro-expression training methods and the no training group. To test the second hypothesis, a MANOVA and 63 *t*-tests, 21 within each group were conducted to assess the post-test accuracy rates of emotion specific micro-expression identification outcomes of the two current micro-expression training methods and no training. A MANOVAs was conducted to determine if there was any difference between the three conditions for post-test outcomes for each emotional

display with a post hoc pairwise comparison to determine if there were any group differences.

Statistical Assumptions

Analysis of variance. According to Tabachnick and Fidell (2007), two or more sample means can be compared via a one way between groups ANOVA. There are three assumptions for a one way between groups ANOVA and MANOVA: (a) observations are independent, (b) the sampling distribution of means for each level of the independent variable is normal, and (c) population variances of dependent variables in each level of the independent variable are homogeneous.

Threats to Validity

External validity. As discussed in Pearl and Bareinboim (2014), to ensure the integrity and the generalizability of a studies results, threats to external validity must be identified. There is currently no consensus on the external validity of micro-expression training in the literature due to how previous studies have utilized a micro-expression displays model which has was shown to be inaccurate (Shen, Sui, & Fu, 2017; Yan et al., 2013).

One potential threat to external validity within the study is the screen-based training, which does not provide variation in the distance in which the micro-expression is viewed from. The lack of variation of distance from which participants viewed the micro-expressions may limited the generalizability of the findings as well as the training. The convenience sample is an additional threat to external validity as it lessens the chance of generalizability.

Internal validity. If a study is unable to measure what it intends to measure it lacks internal validity (Pearl & Bareinboim, 2014). To maximize internal validity, threats to the relationship of the variables within the study must be addressed.

Though unlikely, participants may have discussed the study with other participants. Discussion of the study between participants was addressed during the informed consent process. Within the informed consent process there was a confidentiality statement requesting that the study not be discussed with other members of the MTurk community until the study was completed.

An additional threat to internal validity within the study is previous emotional recognition training. A number of books on body language and deception detection cover this topic and utilize pictures to depict how the universal emotions are displayed, such as *Body Language for Dummies* (Kuhnke, 2012), *Emotions Revealed* (Ekman, 2007), and *The Body Language Advantage* (Glass, 2012). Books on the subject of body language and deception detection make few references to micro-expressions (Porter & ten Brinke, 2013). Deception detection, body language, and as a subset micro-expressions in the media and in books may have led some participants to believe that they had no previous exposure to the subject of the study while they have undertaken a basic understanding of the universal facial expression displays.

Ethical Procedures

I applied all APA and Walden IRB ethical principles to the study and rigorously adhered to these principles. Adherence to these principles began during the informed

consent process, which advised all participants of their right to refuse to participate and to withdraw from the study at any time without negative consequences.

Participant anonymity has been ensured via the study not tracking the IP address of participants as they were able to access the training via their workplace or home. Participants were able to print or save electronically a certificate of completion for the training. Participants were able to enter their name prior to printing or saving the certificate of completion, which allowed individuals to include the training within their annual performance evaluation. Certificates of completion were not saved and as a result, participants could not be tracked, they also could not receive a certificate at a later time.

Data was recorded via the online training program, with the data exported as a Microsoft Excel file, and then transferred to SPSS for analysis. Both raw and statistical data was stored on an Ironkey encrypted external hard drive. This encrypts files utilizing a XTS-AES 256-bit encryption and will erase all data from the hard drive if the password is incorrectly entered 10 times (Ironkey, 2016). The external hard drive is utilized solely for the purpose of storing this information with the data being secured for five years after the completion of the study in this manner. The location of the external hard drive is in a locked cabinet in my home office. Only I have access to the recorded and stored data.

Summary

In this chapter, I discussed the post-test only control group design of the study. The use of web-based data collection was also discussed, as was the empirically supported instruments for data collection and training of the participants to recognize micro-expressions. Members of the MTurk community were recruited through a research

statement of what the study entailed and the URL to the study. The URL randomly assigned participants to one of the three conditions and the site tracked how many participants each condition received through HTML and PHP scripts. Upon completion of data collection, statistical analysis via IBM SPSS version 24.0 was conducted using a three one-way between groups ANOVA of the three experimental groups, picture-based training, video-based training, and no training. Further, a MANOVA and *t*-tests were conducted to determine if within each group specific emotional recognition variances exist. The need to safeguard participant welfare was addressed with a focus on the informed consent process and the prospect for participant-researcher communication during the research process and afterwards.

In Chapter 4, a presentation of the findings are provided, which highlight the various intersections between and within the video-based training group, picture-based training group, and the no training group. The time frame of the study and the events that resulted in obtaining usable data are discussed followed by a summary of the results of the statistical analyses that served to test the research hypotheses: (a) three one-way between groups ANOVA was used to determine whether training method had an impact on micro-expression recognition scores, and (b) a MANOVA and paired *t*-tests were used to determine if there was a difference in participants' ability to recognize specific emotional displays as micro-expressions within and between conditions.

Chapter 4: Results

Micro-expressions are brief facial expressions that last for 500 milliseconds or less and are shown when an individual is concealing their true emotional state in a high stress situation (Ekman et al., 1972; Rinn, 1984). Micro-expression detection has become an important part of deception detection programs including the TSA SPOT program (U.S. GAO, 2013). The impetus on micro-expression recognition developed in part due to the TSA SPOT program which has led to the development of two training methods to recognize micro-expressions. The first of these methods uses picture-based training (Matsumoto & Hwang, 2011), and the second uses video-based training (Kane & O'Byrne, 2014).

Recent studies (Yan et al., 2013) have outlined the manner in which micro-expressions are displayed; however, there is a gap in the scholarly research on whether one of the two training methods results in increased ability to recognize micro-expressions. I undertook this study to address this gap in the literature with two research questions addressing the difference in participants' overall ability to detect micro-expressions between groups and the difference within each group to recognize specific emotions, and between groups for each emotion.

In the following chapter, I present my findings, which highlight the various intersections between and within the video-based training group, picture-based training group, and no training group. First, I discuss the time frame of the study and the events that resulted in obtaining usable data. Second, I present a summary of the results of the statistical analyses that served to test the research hypotheses: (a) three one-way between

groups ANOVAs were used to determine whether training method had an impact on micro-expression recognition scores, and (b) a MANOVA and paired *t* tests were used to determine if there was a difference in participants' ability to recognize specific emotional displays as micro-expressions within and between conditions. I have provided tables to facilitate discussion and optimize reader comprehension.

Data Collection

Time Frame, Actual Recruitment, and Response Rates

A total of 312 participants engaged in the electronic training courses through MTurk via a randomizing URL between May 2018 and June 2018. Based on the power analysis for sample size previously discussed in Chapter 3, 192 total individuals were required, 64 per condition. Of the 312 participant responses, 196 were deemed usable. Of the non-usable responses (a) 74 were excluded from analyses due to partially or fully completing the training, but not attempting the micro-expression recognition post-test, 23 of which were due to server errors; (b) 38 were excluded due to 50% or more of the post-test being incomplete; (c) one participant was excluded because they completed part of the training and then were able to switch to the control group resulting in participation in two groups; and (d) one participant's score on the post-test was greater than three standard deviations from the norm and removed as an extreme outlier (Hamilton, 2010a). As a result, I used data from 64 participants in the video-based and no-training conditions and 67 in the picture-based training condition, totalling 196 participants, for analyses.

Of the 196 usable responses, three had missing data points in the micro-expression recognition post-test, of which all were missing a single data point. I

conducted a missing value analysis (MVA), and found that no variable was missing more than 5% of the data, resulting in the MVA not producing *t* tests. As a result, I deemed that the missing data points were not related to any variable and the data points were thus missing completely at random (MCAR). Because the values were MCAR, I used a mean substitution for the three missing variables as outputted in the MVA (see Hamilton, 2010b; Tabachnick & Fidell, 2007).

No specific data on demographics were collected on participants. Participation was limited to individuals who were part of the MTurk community, 18 years of age and older, lived within the geographic boundaries of the United States, and were fluent in English.

Discrepancies in Data Collection

The original HTML code used to randomize which condition participants would be sent to, caused the website to crash. This lead potential participants to see 404 and 500 server errors, meaning internal server error and server not properly communicating respectively, when potential participants went to the study's website. Both the 404 and 500 errors prevent potential participants from participating in the study at that time. The 404 and 500 server errors were identified within 1 hour of the study being placed on MTurk, which led to the MTurk Human Intelligence Task (HIT) being cancelled to prevent further attempted participation. The server 404 and 500 errors issue was corrected within 16 hours of being identified and the study was reposted on MTurk. The server 404 and 500 errors led to 23 participants leaving the study as they were unable to complete the study within the allotted time frame. Those individuals were monetarily

compensated for their participation because this was a technical issue with the HTML code for study randomization.

Emergence of Adverse Events

Throughout the data collection phase, there were no instances of psychological harm or other adverse events reported by study respondents. Two participants submitted comments stating that they believed that the micro-expression and accompanying emotional recognition training could assist individuals with autism spectrum disorder (ASD) as this related to their personal lives.

Data Cleaning and Screening Procedures

In an effort to avoid bias and statistical confounds, I screened and cleaned data prior to final analysis (see Hamilton, 2010a; Hamilton, 2010b). One hundred fifteen participants were removed before analysis due to missing data, and one participant was removed after the initial analysis because the data from this participant was greater than 3 standard deviations from the mean (Hamilton, 2010a). Outliers that affect the proximity of the mean from the median value and insufficient data due to missing values are two of the four most frequent issues in data analysis (Tabachnick & Fidell, 2007) and were encountered in this study.

Results

Research Question 1

I developed the first research question to examine whether there was a difference between picture-based training, video-based training, and no training to recognize micro-

expressions. Table 1 shows the descriptive statistics for the three conditions as they relate to the independent variable.

Table 1

Descriptive Statistics for VBT, PBT, and NT

IV	*n*	*M*	*SD*	*SE*	95% CI	min	max
VBT	64	30.2813	7.27350	.90919	[28.4644, 32.0981]	8	40
PBT	67	31.5373	5.83700	.71310	[30.1136, 32.9611]	7	42
NT	64	27.1406	6.21536	.77692	[25.5881, 28.6932]	6	42
Total	195	29.6821	6.68985	.47907	[28.7372, 30.6269]	6	42

Note. VBT = video-based training; PBT = picture-based training; NT = no training.

According to Tabachnick and Fidell (2007), two or more sample means can be compared via a one-way between-groups ANOVA. There are three assumptions for a one-way between-groups ANOVA: (a) observations are independent, (b) the sampling distribution of means for each level of the independent variable is normal, and (c) population variances of dependent variables in each level of the independent variable are homogeneous.

To ensure that observations were independent, I checked participants' MTurk identifications to see if an individual participated multiple times because the study was cancelled due to the technical issue, as previously discussed, and then reposted. One individual was identified as participating multiple times, and their data set was removed. To test for normality of distributions for each sample mean, I obtained histograms for each condition and test scores, which indicated normality with slight negative skewness for the picture-based training condition. I further tested for normality by conducting a

Shapiro-Wilk test (see Table 2), with a significance level of $p = .001$ (Tabachnick & Fidell, 2007).

Table 2

Test of Normality for Test Score for VBT, PBT, NT

Condition	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	*df*	*p*	Statistic	*df*	*p*
VBT	.149	64	.001	.896	64	.001
PBT	.120	67	.018	.931	67	.001
NT	.100	64	.188	.944	64	.006

Note. VBT = video-based training; PBT = picture-based training; NT = no training

a. Lilliefors significance correction.

The Shapiro-Wilk test indicated that the distribution was non-normal for the video- and picture-based training groups, and that the no training group was normally distributed. During the normality testing, skewness and kurtosis were also assessed as shown in Table 3. The range for skewness and kurtosis of ± 2 was applied (Field, 2013). Table 3 shows marginal platykurtic characteristics for the no training condition and platykurtic for the picture-based training condition.

Table 3

Central Tendency, Standard Deviation, Skewness, and Kurtosis for VT, PT, NT

Condition	*M*	Median	*SD*	Skewness	Kurtosis
VBT	30.2813	2.2188	7.27350	-1.212	1.289
PBT	31.5373	.4627	5.83700	-1.191	3.501
NT	27.1406	-.1406	6.21536	-.842	2.495

Note. VBT = video-based training; PBT = picture-based training; NT = no training

Though the data were non-normally distributed because there were greater than 20 degrees of freedom within the conditions, the *F* test was robust to violations of normality

because outliers were removed from the data set. The practice of using data that is non-normally distributed within an MANOVA and ANOVA is generally accepted practice within statistical analysis (Tabachnick & Fidell, 2007). Therefore, the data were not transformed to assess the first research question.

To test for homogeneity of variances, *F* values for Levene's statistic are shown in Table 4. I selected Levene's test of homogeneity of variances because it is not sensitive to departures from normality (Tabachnick & Fidell, 2007). The results revealed no significant differences between group variances.

Table 4

Levene's Test of Homogeneity of Variances for VT, PT, and NT

F(*2, 192*)	*df*1	*df*2	*p*
1.883	2	192	.155

A three-group one-way between-groups ANOVA was conducted to determine if a significant difference was present between the three conditions. The results revealed statistically significant differences in training outcomes between the three conditions at the $p < .001$ level for the effect of training [$F(2, 192) = 7.988$, $p < .001$, $n^2 = .077$] - a small effect (see Table 5). These findings suggest that micro-expression recognition was impacted by training.

Table 5

ANOVA for VBT, PBT, and NT

	Sum of Squares	*df*	*MS*	*F*	*P*	n^2
Between Groups	666.959	2	333.479	7.988	.001	.077
Within Groups	8015.329	192	41.747			
Total	8682.287	194				

Note. VBT = video-based training; PBT = picture-based training; NT = no training

To determine which training method, if any, produced the highest impact on micro-expression recognition, I used a post-hoc analysis involving a Tukey's test for multiple comparisons (Tukey, 1953) to obtain simultaneous contrasts of condition means (see Table 6). The Tukey's test was selected as compared to other tests because it optimally adjusts for a Type II error (Williams & Abdi, 2010).

Table 6

Tukey's Tests for Multiple Comparisons: VBT, PBT, and NT

(I) Condition	(J) Condition	M Diff. (I-J)	*SE*	*p*	95% CI
VBT	PBT	-1.25606	1.12932	.508	[-3.9236, 1.4114]
	NT	3.14063*	1.14218	.018	[.4428, 5.8385]
PBT	NT	4.39669*	1.12932	.001	[1.7292, 7.0642]

Note. VBT = video-based training, PBT = picture-based training, NT = no training.

The Tukey's post-hoc comparison showed that both video-based training (M = 30.28, SD = 7.27, 95% CI [28.4644, 32.0981]) and picture-based training (M = 31.53, SD = 5.84, 95% CI [30.1136, 32.9611]) were statistically significant from no training (M =27.14, SD = 6.22, 95% CI [25.5881, 28.6932]) at the $p < .05$ level. There was no significant difference between the video-based training and the picture-based training in micro-expression recognition ability.

Research Question 2

The second research question examined the difference, if any, in ability to recognize specific facial expressions within and between groups. The analysis was completed in two stages. The first stage was a between groups analysis and the second stage was a within groups analysis.

Between groups.To ensure that observations were independent, I checked participants' MTurk identifications to see if an individual participated multiple times as the study was cancelled due to the technical issue, as previously discussed, and then reposted. One individual was identified as having participated in multiple conditions and the corresponding data were removed. To test for normality of distributions for each sample mean, histograms for each condition and test scores were obtained, which indicated normality with slight negative skewness for the picture-based training condition. Further testing of normality was assessed by conducting a Shapiro-Wilk test (see Table 7), with a significances level of $p = .001$ (Tabachnick & Fidell, 2007).

Table 7

Test of Normality for Test Score for VBT, PBT, NT

Condition	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	*df*	*p*	Statistic	*df*	*p*
Video training	.149	64	.001	.896	64	.001
Picture training	.120	67	.018	.931	67	.001
No training	.100	64	.188	.944	64	.006

Note. VBT = video-based training; PBT = picture-based training; NT = no training
a. Lilliefors Significance Correction

The Shapiro-Wilk test indicated that the distribution was non-normal for the video and picture-based training groups, and the no training group was normally distributed.

During the normality testing, skewness and kurtosis were also assessed as shown in Table 8. The range for skewness and kurtosis of ± 2 were applied (Field, 2013). Table 8 shows marginal platykurtic characteristics for the no training condition and platykurtic for the picture-based training condition.

Table 8

Central Tendency, Standard Deviation, Skewness, and Kurtosis for VBT, PBT, NT

Condition	*M*	Median	*SD*	Skewness	Kurtosis
VBT	30.2813	2.2188	7.27350	-1.212	1.289
PBT	31.5373	.4627	5.83700	-1.191	3.501
NT	27.1406	-.1406	6.21536	-.842	2.495

Note. VBT = video-based training; PBT = picture-based training; NT = no training

Though the data are non-normally distributed, as there are greater than 20 participants within the conditions, the *F* and *t* tests are robust to violations of normality as outliers were removed from the data set. The practice of utilizing data that are non-normally distributed within an MANOVA and ANOVA is a generally accepted practice within statistical analysis (Tabachnick & Fidell, 2007). Therefore, the data were not transformed to assess the second research question.

To test for homogeneity of variances, F values for Levene's statistic are shown in Table 9. The results revealed no significant differences between group variances.

Table 9

Levene's Test of Homogeneity of Variances for VBT, PBT, and NT

Emotion	*F*(*2, 192*)	*df*1	*df*2	*p*
Anger	.041	2	192	.960
Contempt	3.524	2	192	.031
Disgust	1.901	2	192	.152
Fear	1.196	2	192	.305
Happy	2.955	2	192	.054
Sad	.556	2	192	.575
Surprise	1.413	2	192	.246

Note. VBT = video-based training; PBT = picture-based training; NT = no training

A MANOVA was employed to assess the differences if any between the three groups in micro-expression recognition outcome (see Table 10). Using Pillar's Trace, there was a significant effect of training on micro-expression recognition, $V = 0.17$, $F(14, 374) = 2.48$, $p = .002$. However, separate univariate ANOVAs (see Table 11) on the outcome variables revealed non-significant treatment effects for micro-expression recognition on disgust, $F(2, 192) = 1.18$, $p = .311$, happiness, $F(2, 192) = 0.79$, $p = .455$, sadness, $F(2, 192) = 2.45$, $p = .3089$, and surprise, $F(2, 192) = .692$, $p = .5$. Results of the univariate ANOVAs also revealed that anger, $F(2, 192) = 10.19$, $p = .001$, contempt, $F(2, 192) = 9.7$, $p = .001$, and fear $F(2, 192) = 3.243$, $p = .041$, showed significant treatment effects for micro-expression recognition.

Table 10

Pillai's Trace for Multivariate Analysis of Variance

Effect	Value	*F*	*df*	*p*	Partial Eta Squared
Pillai's Trace	.170	2.482	14	.002	.085

Table 11

Test of Between Subjects Effects

Variable	Type III SS	*df*	*MS*	*F*	*p*	n^2
Anger	53.323[a]	2	26.662	10.185	.001	.096
Contempt	48.120[b]	2	24.060	9.704	.001	.092
Disgust	5.160[c]	2	2.580	1.175	.311	.012
Fear	16.733[d]	2	8.367	3.243	.041	.033
Happy	1.535[e]	2	.768	.791	.455	.008
Sad	15.720[f]	2	7.860	2.453	.089	.025
Surprise	2.291[g]	2	1.145	.692	.502	.007

a. R Squared = .096 (Adjusted R Squared = .086)
b. R Squared = .092 (Adjusted R Squared = .082)
c. R Squared = .012 (Adjusted R Squared = .002)
d. R Squared = .033 (Adjusted R Squared = .023)
e. R Squared = .008 (Adjusted R Squared = -.002)
f. R Squared = .025 (Adjusted R Squared = .015)
g. R Squared = .007 (Adjusted R Squared = -.003)
h. Computed using alpha = .05

To determine which training method, if any, produced the highest impact on recognition of specific emotions of micro-expression, a post-hoc analysis that employed a Tukey's test for multiple comparisons (Tukey, 1953) was employed to obtain simultaneous contrasts of condition means (see Table 12). The Tukey's test was selected as compared to other tests because it optimally adjusts for a Type II error (Williams & Abdi, 2010).

Table 12

Tukey's Tests for Multiple Comparisons: VT, PT, and NT for the Universal Emotions

Variable	(I) Training condition	(J) Training Condition	M Diff. (I-J)	*SE*	*p.*	95% CI
Anger	video-based training	picture-based training	-.1467	.28280	.862	[-.8147, .5213]
		no training	1.0313*	.28602	.001	[.3557, 1.7068]
	picture-based training	no training	1.1779*	.28280	.001	[.5100, 1.8459]
Contempt	video-based training	picture-based training	-.0504	.27523	.982	[-.7005, .5997]
		no training	1.0313*	.27836	.001	[.3738, 1.6887]
	picture-based training	no training	1.0816*	.27523	.001	[.4315, 1.7317]
Disgust	video-based training	picture-based training	-.1241	.25898	.881	[-.7358, .4877]
		no training	.2656	.26193	.569	[-.3531, .8843]
	picture-based training	no training	.3897	.25898	.291	[-.2220, 1.0014]
Fear	video-based training	picture-based training	-.3708	.28076	.385	[-1.0340, .2924]
		no training	.3438	.28396	.448	[-.3270, 1.0145]
	picture-based training	no training	.7146*	.28076	.031	[.0514, 1.3777]
Happy	video-based training	picture-based training	-.2157	.17221	.424	[-.6225, .1910]
		no training	-.0938	.17417	.853	[-.5051, .3176]
	picture-based training	no training	.1220	.17221	.759	[-.2848, .5287]
Sad	video-based training	picture-based training	-.1472	.31289	.885	[-.8862, .5919]
		no training	.5156	.31645	.236	[-.2318, 1.2631]
	picture-based training	no training	.6628*	.31289	.089	[-.0763, 1.4018]
Surprise	video-based training	picture-based training	-.2013	.22486	.644	[-.7324, .3299]
		no training	.0469	.22743	.977	[-.4903, .5841]
	picture-based training	no training	.2481	.22486	.513	[-.2830, .7793]

Note. VBT = video-based training; PBT = picture-based training; NT = no training

The Tukey's post-hoc comparison showed that anger recognition was affected by the video-based training (M = 30.28, SD = 7.27, 95% CI [.3557, 1.7068], p <.001) and picture-based training (M = 31.53, SD = 5.84, 95% CI [.5100, 1.8459] , p <.001), contempt recognition was effected by the video-based training (M= 30.28, SD = 7.27, 95% CI [.3738, 1.6887] , p <.001) and picture-based training (M = 31.53, SD = 5.84, 95% CI [.4315, 1.7317] , p <.001), and fear recognition was effected by picture-based training (M = 31.53, SD = 5.84, 95% CI [.0514, 1.3777] , p <.031). There was no significant difference between the video-based and the picture-based training in micro-expression recognition ability among all seven emotions, and no difference between the experimental and control conditions for disgust, happiness, sadness, and surprise.

Within Groups

I conducted a within groups analysis via paired *t*-tests, with 63 total t-tests, 21 per condition. Assumptions for the paired sample t-test is normality of variance. To test this, a Levene's test of homogeneity was conducted and F values for Levene's statistic are shown in Table 13. Levene's Test of Homogeneity of Variances was selected as it is not sensitive to departures from normality (Tabachnick & Fidell, 2007). A significance value of $p < .005$ was utilized, and results indicated that no significant differences existed between group variances.

Table 13

Levene's Test of Homogeneity of Variances for VBT, PBT, and NT

F(*2, 192*)	*df*1	*df*2	*p*
1.883	2	192	.155

Note. VBT = video-based training; PBT = picture-based training; NT = no training

The range for skewness and kurtosis of ± 2 were applied (Field, 2013). Table 14 shows marginal platykurtic characteristics for the no training condition and platykurtic for the picture-based training condition.

Table 14

Central Tendency, Standard Deviation, Skewness, and Kurtosis for VBT, PBT, NT

Condition	M	Median	SD	Skewness	Kurtosis
VBT	30.2813	2.2188	7.27350	-1.212	1.289
PBT	31.5373	.4627	5.83700	-1.191	3.501
NT	27.1406	-.1406	6.21536	-.842	2.495

Note. VBT = video-based training; PBT = picture-based training; NT = no training

Three sets of paired t-test were conducted, one per condition, in order to examine if there were any differences in ability to recognize specific expressions within each condition. As shown in Table 15, within the video-based training condition only, four interactions were not significant at the $p < .05$ level. These were, anger and fear, with a mean difference of -.33, CI [-.71370, .05745], $t(63) = -1.7$, $p = .094$, anger and sadness, with a mean difference of .34, CI [-.19810, .88560], $t(63) = 1.3$, $p = .21$, contempt and disgust, with a mean difference of 3.1, CI [-.12101, .74601], $t(63) = 1.4$, $p = .155$, and contempt and surprise with a mean difference of -.3, CI [-.76932, .17557], $t(63) = -1.3$, $p = .214$.

Table 15

Video-Based Training Emotional Comparisons

Emotions	*M*	*SD*	*SE*	95% CI	*t*	*df*	*p*
Anger - Contempt	-1.48438	1.90231	.23779	[-1.95956, -1.00919	-6.242	63	.001
Anger - Disgust	-1.17188	1.80436	.22554	[-1.62259, -.72116]	-5.196	63	.001
Anger - Fear	-.32813	1.54360	.19295	[-.71370, .05745]	-1.701	63	.094
Anger - Happy	-2.12500	1.71362	.21420	[-2.55305, -1.69695]	-9.920	63	.001
Anger - Sad	.34375	2.16918	.27115	[-.19810, .88560]	1.268	63	.210
Anger - Surprise	-1.78125	1.78591	.22324	[-2.22736, -1.33514]	-7.979	63	.001
Contempt - Disgust	.31250	1.73548	.21694	[-.12101, .74601]	1.441	63	.155
Contempt - Fear	1.15625	1.61559	.20195	[.75269, 1.55981]	5.725	63	.001
Contempt - Happy	-.64063	1.75813	.21977	[-1.07979, -.20146]	-2.915	63	.005
Contempt - Sad	1.82813	1.80436	.22554	[1.37741, 2.27884]	8.105	63	.001
Contempt - Surprise	-.29688	1.89133	.23642	[-.76932, .17557]	-1.256	63	.214
Disgust - Fear	.84375	1.68296	.21037	[.42336, 1.26414]	4.011	63	.001
Disgust - Happy	-.95313	1.44123	.18015	[-1.31313, -.59312]	-5.291	63	.001
Disgust - Sad	1.51563	1.92718	.24090	[1.03423, 1.99702]	6.292	63	.001
Disgust - Surprise	-.60938	1.47591	.18449	[-.97805, -.24070]	-3.303	63	.002
Fear - Happy	-1.79688	1.44946	.18118	[-2.15894, -1.43481]	-9.917	63	.001
Fear - Sad	.67188	1.73713	.21714	[.23795, 1.10580]	3.094	63	.003
Fear - Surprise	-1.45313	1.62256	.20282	[-1.85843, -1.04782]	-7.165	63	.001
Happy - Sad	2.46875	1.65202	.20650	[2.05609, 2.88141]	11.955	63	.001
Happy - Surprise	.34375	1.26263	.15783	[.02835, .65915]	2.178	63	.033
Sad - Surprise	-2.12500	1.94773	.24347	[-2.61153, -1.63847]	-8.728	63	.001

As shown in Table 16, within the picture-based training condition, only two interactions were not significant at the $p < .05$ level. These were, anger and sadness, with a mean difference of .34, CI [-.19808, .88464], $t(66) = 1.3$, $p = .21$, and contempt and disgust, with a mean difference of .24, CI [-.19440, .67201] $t(66) = 1.1$, $p = .275$.

Table 16

Picture-Based Training Emotional Comparisons

Emotions	*M*	*SD*	*SE*	95% CI	*t*	*df*	*p*
Anger - Contempt	-1.38806	1.66929	.20394	[-1.79523, -.98089]	-6.806	66	.001
Anger - Disgust	-1.14925	1.89300	.23127	[-1.61099, -.68751]	-4.969	66	.001
Anger - Fear	-.55224	2.14817	.26244	[-1.07622, -.02826]	-2.104	66	.039
Anger - Happy	-2.19403	1.56901	.19168	[-2.57674, -1.81132]	-11.446	66	.001
Anger - Sad	.34328	2.21942	.27115	[-.19808, .88464]	1.266	66	.210
Anger - Surprise	-1.83582	1.65691	.20242	[-2.23997, -1.43167]	-9.069	66	.001
Contempt - Disgust	.23881	1.77601	.21697	[-.19440, .67201]	1.101	66	.275
Contempt - Fear	.83582	1.54328	.18854	[.45938, 1.21226]	4.433	66	.001
Contempt - Happy	-.80597	1.22151	.14923	[-1.10392, -.50802]	-5.401	66	.001
Contempt - Sad	1.73134	2.01947	.24672	[1.23876, 2.22393]	7.018	66	.001
Contempt - Surprise	-.44776	1.50034	.18330	[-.81372, -.08180]	-2.443	66	.017
Disgust - Fear	.59701	1.69723	.20735	[.18303, 1.01100]	2.879	66	.005
Disgust - Happy	-1.04478	1.23623	.15103	[-1.34632, -.74324]	-6.918	66	.001
Disgust - Sad	1.49254	1.98000	.24190	[1.00958, 1.97550]	6.170	66	.001
Disgust - Surprise	-.68657	1.38399	.16908	[-1.02415, -.34899]	-4.061	66	.001
Fear - Happy	-1.64179	1.51459	.18504	[-2.01123, -1.27235]	-8.873	66	.001
Fear - Sad	.89552	1.75926	.21493	[.46641, 1.32464]	4.167	66	.001
Fear - Surprise	-1.28358	1.73909	.21246	[-1.70778, -.85939]	-6.041	66	.001
Happy - Sad	2.53731	1.85316	.22640	[2.08529, 2.98933]	11.207	66	.001
Happy - Surprise	.35821	.81094	.09907	[.16041, .55601]	3.616	66	.001
Sad - Surprise	-2.17910	1.94567	.23770	[-2.65369, -1.70452]	-9.167	66	.001

As shown in Table 17, within the no training condition, only three interactions were not significant at the $p < .05$ level. These were, anger and sadness, with a mean difference of -.17, CI -.69576, .35201], $t(63) = -.66$, $p = .514$, contempt and disgust, with a mean difference of -.45, CI -.91764, .01139], $t(63) = -2$, $p = .056$, and contempt and fear with a mean difference of .47, CI [-.10635, 1.04385], $t(63) = 1.6$, $p = .108$.

Table 17

No Training Emotional Recognition Comparison

Emotions	*M*	*SD*	*SE*	95% CI	*t*	*df*	*p*
Anger - Contempt	-1.48438	2.26072	.28259	[-2.04909, -.91966]	-5.253	63	.001
Anger - Disgust	-1.93750	2.23873	.27984	[-2.49672, -1.37828]	-6.924	63	.001
Anger - Fear	-1.01563	2.20023	.27503	[-1.56523, -.46602]	-3.693	63	.001
Anger - Happy	-3.25000	1.84305	.23038	[-3.71038, -2.78962]	-14.107	63	.001
Anger - Sad	-.17188	2.09727	.26216	[-.69576, .35201]	-.656	63	.514
Anger - Surprise	-2.76563	1.90856	.23857	[-3.24237, -2.28888]	-11.592	63	.001
Contempt - Disgust	-.45313	1.85959	.23245	[-.91764, .01139]	-1.949	63	.056
Contempt - Fear	.46875	2.30230	.28779	[-.10635, 1.04385]	1.629	63	.108
Contempt - Happy	-1.76563	1.78834	.22354	[-2.21234, -1.31891]	-7.898	63	.001
Contempt - Sad	1.31250	2.30854	.28857	[.73584, 1.88916]	4.548	63	.001
Contempt - Surprise	-1.28125	1.79478	.22435	[-1.72957, -.83293]	-5.711	63	.001
Disgust - Fear	.92188	2.08018	.26002	[.40226, 1.4414]9	3.545	63	.001
Disgust - Happy	-1.31250	1.58239	.19780	[-1.70777, -.91723]	-6.636	63	.001
Disgust - Sad	1.76563	2.27995	.28499	[1.19611, 2.33514]	6.195	63	.001
Disgust - Surprise	-.82813	1.66719	.20840	[-1.24458, -.41167]	-3.974	63	.001
Fear - Happy	-2.23438	1.83218	.22902	[-2.69204, -1.77671]	-9.756	63	.001
Fear - Sad	.84375	1.93726	.24216	[.35984, 1.32766]	3.484	63	.001
Fear - Surprise	-1.75000	1.81703	.22713	[-2.20388, -1.29612]	-7.705	63	.001
Happy - Sad	3.07813	2.07253	.25907	[2.56042, 3.59583]	11.882	63	.001
Happy - Surprise	.48438	.97577	.12197	[.24063, .72812]	3.971	63	.001
Sad - Surprise	-2.59375	2.04488	.25561	[-3.10455, -2.08295]	-10.147	63	.001

Summary

In analyzing the data, a number of important findings relating to micro-expression recognition were observed. For the three one-way between groups analysis for the first research question, results of the ANOVA revealed a statistical significant difference between the three groups, video-based training, picture-based training, and no training. Post-hoc analysis were conducted using Tukey's tests for multiple comparisons to determine mean recognition of micro-expressions between each group. The picture-based training and no training, as well as the video-based training and no training, were statistically significant in their training outcomes with both picture-based training and video-based training having higher mean recognition test scores than no training. Though mean micro-expression recognition scores were higher for the picture-based training group over the video-based training group, the picture-based and video-based training were not statistically different in training outcomes, $p = .508$.

Research Question 2 looked to see if there were differences within and between groups in ability to recognize seven specific emotions displayed as micro-expressions. Research Question 2 was answered in two parts; the first analysis was between groups and the second was within groups. To determine if there was a difference between specific facial expressions, a MANOVA was conducted comparing video-based training, picture-based training, and no training. The results revealed a statistically significant difference and a post hoc analysis was conducted to determine where the differences existed. Anger and contempt were affected by both video-based and picture-based training at a statistically significant level, and fear was affected by the picture-based

training at a statistically significant level. No difference existed in ability to recognize any of the other emotional displays between the video-based and the picture-based training.

The within group analysis was conducted by completing a series of paired sample *t*-tests. Twenty-one paired *t*-tests were conducted for each of the conditions. The majority of the comparisons were statistically significant. Anger and sadness, as well as contempt and disgust, were not significantly different in all three groups. Anger and fear as well as contempt and surprise were not significantly different in the video-based training condition, and contempt and fear were not significantly different in the no training condition. All other pairs were significantly different in all three groups.

In Chapter 5, a concluding summary of the study is provided. Included is the interpretation of the findings, the study limitations, recommendations for future research, and the study's implications for positive social change. The chapter concludes with recommendations for micro-expression training.

Chapter 5: Conclusion and Future Directions

Micro-expressions were originally discovered in 1966 when two clinical psychologists were reviewing video recordings of clinical interviews and noted that a patient appeared sad when the videos were played in slow motion despite stating that she was happy (Haggard & Issacs, 1966). This finding led to further research on the subject of brief emotional displays, which came to be known as micro-expressions. Few researchers have looked at the efficacy of training to assist in micro-expression recognition, and no previous researchers have sought to understand the differences in training outcomes, if any, between the two methods of training individuals to recognize micro-expressions.

In this study, I looked at three distinct aspects of micro-expression recognition. First, I sought to understand if there was any difference in training outcome between picture-based training, video-based training, and no training on recognition of micro-expressions at a length of 360 milliseconds. The results showed statistically significant mean differences between the three conditions, and post-hoc testing showed statistical differences between video-based training and no training as well as picture-based training and no training.

I also sought to understand if there was any difference between the three conditions in participants' abilities to recognize each emotion. There were no statistically significant differences between the video- and picture-based training conditions. Anger and contempt recognition showed statistically significant mean differences in both the video-based and picture-based training and recognition over no training, and fear

recognition showed statistically significant mean differences in the picture-based training over no training.

Last, I looked at differences within each condition, comparing the ability to recognize the seven different emotions. I compared the within condition ability to recognize emotions via a series of paired *t* tests. The majority of the paired *t* tests were statistically significant. Anger and sadness, as well as contempt and disgust, were not significantly different from each other in all three conditions. Anger and fear, as well as contempt and surprise, were not significantly different in the video-based training condition, and contempt and fear were not significantly different in the no training condition. With the research objectives having been met, the evidence revealed numerous noteworthy outcomes on how micro-expression training effects the ability to recognize micro-expressions.

Interpretation of the Findings

Training Outcomes

The analysis for the first research question showed statistically significant mean omnibus differences between video-based training, picture-based training, and no training in ability to recognize micro-expressions. Post-hoc analysis showed that picture-based training and video-based training were both statistically significant in mean scores over no training though not from each other. The finding that training has a statistically significant effect on micro-expression recognition corroborates previous studies by Matsumoto and Hwang (2011), and Kane and O'Byrne (2014).

In total, the emotional display lasted 360 milliseconds, with the highest intensity of the emotional display lasting for 30 milliseconds for the post-test which was provided to participants in the three conditions. Previous studies have shown that individuals can accurately recognize images after an exposure of only 16.67 milliseconds (Ball, Edwards & Ross, 2007). The highest intensity of the emotion was displayed for nearly twice the required time for proper image identification. The length of time in which the highest intensity of the emotional display is shown during micro-expression displays (Yan et al., 2013) is approximately twice the required time to properly recognize an image with an accuracy rate of 75% (Ball et al., 2007). The ability to accurately recognize images after an exposure of 16.67 milliseconds likely led to similar mean scores for the picture-based and video-based training groups, and no statistically significant difference between these groups in training outcomes. The study's finding addresses a gap in the current literature by showing that no significant difference occurs between overall picture-based and video-based training in micro-expression recognition, likely do to the minimal amount of time, 16.67 milliseconds, which individuals require to view an image to properly identify it.

Between Group Differences in Ability to Recognize Specific Emotions

I addressed the second research question in two parts. In the first part, I addressed differences between the three conditions in ability to recognize specific emotional displays. No statistically significant differences between the video-based training and picture-based training were present. Anger, contempt, and fear were the only emotions that were identified to have statistically significant mean omnibus between-group

differences. A post-hoc analysis indicated recognition of anger and contempt were affected at a statistically significant level, $p < .05$, by both picture-based and video-based training. Fear was affected at a statistically significant level, $p < .05$, by the picture-based training. I found no previous studies that addressed outcomes for recognition of specific emotions as micro-expressions. Of note is that only three of the seven emotions were affected at a statistically significant level of $p < .05$ due to the training. Previous studies have indicated that happiness is the emotion that is properly identified without training the majority of the time when a single facial expression of emotion is being decoded in macro-expressions and in pictures. Negative emotions such as anger, contempt, disgust, and fear are often mistaken for each other in these same circumstances (Custrini & Feldman, 1989; Horatcsu & Ekinci, 1992; Marsh et al., 2005).

The increased ability of participants to properly recognize anger and contempt is explained by the above noted issues in emotional recognition of a single facial expression of emotion because instruction in the differences in these emotional displays allows individuals to increase proper identification of the displayed emotion while decreasing misidentification of these emotions. However, these studies do not provide a rationale for the similar means of the picture-based ($M = 4.6866$) and video-based training ($M = 4.5625$) conditions, and the no training ($M = 4.2969$) condition in recognition of disgust. I found no studies that indicate a rationale for why recognition of happiness and surprise were not affected by the training or why there is a natural ability to recognize these emotions, which would negate the importance of training. Researchers have suggested that each of the seven universal emotions is composed of recognized neural systems that

are relatively specialized for processing each emotional display (Adolphs, 2002). This supports Darwin's (1872) theory of the universality of emotional expression and others' abilities to recognize other individual's expression due to their instinctual aspects. Darwin further theorized that certain emotional displays evolved from primitive facial displays and the primitive facial displays were more necessary for survival leading to these primitive emotions being more easily recognized throughout humanity.

The three conditions had similar means for surprise: video-based training (M = 5.1719), picture-based training (M = 5.3731), and no training (M = 5.125). The findings indicate that surprise, similar to happiness, is universally recognized and training has a limited effect on an individual's ability to recognize this emotion as displayed as a micro-expression. Studies have shown that fear and surprise are often mistaken for one another, and an evolutionary explanation for recognition of fear and surprise as a survival mechanism to alert others to a threat may provide a rationale for this outcome. The premise of humans' natural ability to recognize surprise is supported by prior research hypothesizing that current facial expression have evolved to provide an increased level of information, and did so from a simpler system of facial emotional communication (Dunbar, 1998; Enquist, 1993; Huxley, 1966; Jack, Garrod, & Schyns, 2014).

Sadness may be affected by gender differences in emotional recognition ability. Previous studies have shown that there is a difference in overall emotional identification ability between the genders, with women having superior identification abilities, though not at a statistically significant level (Nowicki & Duke, 1994). In the Nowicki and Duke study, individual emotion recognition was not assessed. Males who adhere to traditional

masculine norms have been shown to have a lower emotional intelligence, which may have impacted the Nowicki and Duke findings. Traditional masculine norms is operationalized as decreased emotional understanding, motivation, and management of one's emotions and comprehension of others emotions (Mahalik et al., 2003). Further, an adherence to traditional masculine norms is associated with the decreased ability to properly identify emotional expressions in others (Burgoon et al., 2010). However it should be noted that the Nowicki and Duke study was limited by not addressing individuals emotional recognition, and utilized a skewed gender balance, with more females than males in the study.

Within Group Differences in Ability to Recognize Specific Emotions

I used the within group analysis to answer the second portion of Research Question 2. The analysis was conducted by completing a series of paired sample *t* tests. I conducted 21 paired *t* tests for each of the conditions. The majority of the comparisons were statistically significant, suggesting that training affects individual's ability to recognize micro-expressions at varying degrees of effectiveness. Anger and sadness, as well as contempt and disgust, were not significantly different in all three groups. In addition, anger and fear, as well as contempt and surprise, were not significantly different in the video-based training condition, and contempt and fear were not significantly different in the no training condition. The within group findings that training affects micro-expression recognition to varying degrees supports the between group findings, and shows that specific emotions require modification to ensure that the seven universal

emotions displayed as micro-expressions are able to be recognized at similar levels of accuracy.

If the no training condition is excluded and the two training conditions are assessed for within group difference, there are large differences in the ability to recognize specific emotions within each training condition. The training provides similar explanations, descriptions, and examples of the seven emotions. If surprise and happiness are removed from the interpretation of the findings given their high means of recognition within the three conditions, and the finding that anger and contempt recognition are impacted by training, it can be concluded that the training for disgust, fear, and sadness requires modification to ensure that these emotions can be recognized as effectively as the other four emotions. It is currently unknown what modifications to the training would result in increased accuracy rates for these emotions.

Limitations of the Study

I conducted this study via online training with participants recruited through MTurk. As a result, a number of factors may have impacted the reliability of the obtained data. As discussed in Chapter 1, participants were requested to agree that they had no prior training in emotional or micro-expression recognition. The study paid participants $3.00 for their time, which is 50% greater than the average hourly wage on MTurk (Hara et al., 2018). Though the majority of American MTurk participants are employed (53%) and thus a minimal amount of their income comes from MTurk participation, 10% of Americans who use MTurk state that it is their primary source of income (Kulwin, 2016). The relatively large monetary compensation for participation in the study may have

caused some individuals who had previous training in emotional or micro-expression recognition to participate in the study for monetary gain. Despite this, Paolacci and Chandler (2014) stated that increased pay on MTurk leads to less false and random answers, though Buhrmester, Kwang, and Gosling (2011) indicated that there is no relationship between pay and work quality in psychological studies on MTurk.

Despite this, it is unlikely that a significant number of participants, if any, had previously received training in emotional and or micro-expression recognition because the obtained results aligned with findings in previous studies on micro-expression training (Matsumoto & Hwang, 2011; Kane & O'Byrne, 2014). Further, the use of an HTML code to randomly place participants in one of the three conditions controlled for systemic factors such as this (see Frankfort-Nachmias & Nachmias, 2008). The use of MTurk allowed for a convenience sampling and no specific demographic data were collected; therefore, the findings cannot be generalized due to the limitations of convenience sampling as discussed in Chapter 1.

The use of computer-based training allows for consistency in the independent variable across participants. However, there are limitations to this method when providing training in recognizing micro-expressions. Different cultures and sub-cultures in the United States have differences in mean personal space, and males and females have differences in mean height (Burgoon, Guerrero & Floyd, 2010). Training that uses virtual reality or augmented reality would allow for participants to obtain training while adapting to address the issues of personal space and height differences in micro-expression recognition among cultural, sub-cultural, and gender differences. These differences are

encountered in real world instances of micro-expression displays and recognition. As such, training which could be modified to adjust to the characteristics of the trainee could be an important step forward in micro-expression recognition training.

As addressed in Chapter 4, data collection was originally halted due to issues with webhosting. Though there was minimal participation in the training and post-test during this time, it is possible that these issues had an impact upon data collection as participants may have discussed of the study with other MTurk users providing them with information about the training. The randomization of participant placement in the three conditions should have controlled for this issue though.

Recommendations

Due to the findings of the current study I make numerous recommendations for future research. The following sections highlight the recommendations as they apply to future research in micro-expression recognition training.

Data Collection and Demographics

There currently exists known differences in emotional recognition between males and females, between age groups, and between ethnic groups (Burgoon, Guerrero, & Floyd, 2010). It is unknown how these differences impact the ability of individuals to recognize micro-expressions, if at all. Future studies should consider collecting demographic information on participants to determine if there is a statistically significant difference within and between genders, age groups, and ethnic groups in their ability to recognize emotions displayed as micro-expressions.

Virtual Reality and Micro-Expression Training

Virtual reality provides users with an immersive virtual environment, which incorporates the participant's movement and height into their surroundings in order to allow for a fully simulated environment (Freina & Ott, 2015). The use of a computer screen limits the environment in which participants are able to learn to recognize micro-expressions to the images and videos shown on the monitor. A virtual environment would allow participants to learn to recognize micro-expressions from individuals varying in height, facial features, ethnicities, genders, and distances to incorporate multiple cultural norms for personal space as well as at longer distances. Though all studies on training individuals to recognize micro-expressions have incorporated both males and female of multiple ethnicities displaying micro-expressions (Kane & O'Byrne, 2014; Matsumoto & Hwang, 2011), none have incorporated multiple angles of recognition on the x, y, and z axis. These variables are likely to impact micro-expression training and recognition due to increasing the complexity of observing the entirety of the facial expression. Virtual reality would be an ideal platform for assessing individual's abilities to recognize micro-expressions across a number of demographic variables, adjusting for the trainee's persona characteristics, as well as from multiple angles.

Gender Differences in Emotional Recognition due to Differences in Socialization to Emotions

As previously noted, an adherence to masculine norms is associated with a decrease in an individual's emotional intelligence (Mahalik et al., 2003). A result of this may be that individuals who score high on masculine norms have a decreased ability to

recognize micro-expressions similar to their limitations in their ability to recognize macro-expressions of emotions (Mahalik et al., 2003). Future research may consider incorporating a scale of adherence to masculine norms into the study to determine what, if any, effect adherence to masculine norms has on micro-expression recognition ability with and without training.

Efficacy of Training on Specific Emotions

The within groups analysis indicated that there is a statistically significant difference in the ability to recognize the universal emotions as micro-expressions. I found that disgust, fear, and sadness were shown not to be affected by training in the current study. Future research should compare various training methods for recognition of each of the seven universal emotions to determine the optimal training material for each emotion.

Varying Levels of Emotional Intensity

Studies by Porter and tenBrink (2008; 2012) and Yan et al. (2013) showed that micro-expressions are displayed in a variety of emotional intensity levels. Though the majority of micro-expressions reach the highest intensity level of emotional display (Yan et al., 2013), micro-expressions are displayed in a variety of intensity levels as outlined in FACS (Ekman, Friesen & Hager, 2002). Future studies should determine if current training is able to allow individuals to recognize a variety of emotional intensity levels as displayed within a micro-expression.

Length of Micro-Expression Displays

Recent studies by Yan et al. (2013) determined that micro-expression can range in length from 166.67 milliseconds to 502.78 milliseconds. In the current study I only tested individuals on their ability to recognize micro-expressions at the duration of 360 milliseconds. Previous studies have tested individuals' ability to recognize micro-expressions at the highest intensity of emotional display for 200 milliseconds (Matsumoto & Hwang, 2011) and in the same manner as the current study (Kane & O'Byrne, 2011). As the range in which micro-expressions are displayed is 336.11 milliseconds, future research should determine the effect, if any, which micro-expression duration has on micro-expression recognition.

Implications for Positive Social Change

Since micro-expressions were originally discovered and research published on them began in the 1960's, the social constructs of society and international security have been vastly altered (US GAO, 2013). Deception detection training and micro-expression training has been provided to a number of government and civilian organizations, and in the years since the 9/11 attacks, this number has increased dramatically and yet little is known of the efficacy of micro-expression training and recognition ability (U.S. GAO, 2013). One of the primary concerns regarding micro-expression and deception detection training expressed by the U.S. GAO (2013) was the lack of scientific evidence supporting the efficacy of the training. The current study adds to the limited knowledge base validating that micro-expression training is effective at training individuals to properly identify micro-expressions.

As the U.S. GAO (2013) report largely dealt with TSA SPOT program, which employs individuals charged with detecting individuals carry contraband onto planes, it is necessary for these individuals to have proper training in recognizing deception and threats. The study's findings can also apply to other organizations that provide protective services such as the armed forces, police, firefighters, and emergency responders. Further increasing the understanding of micro-expression training and adding additional empirical evidence that micro-expressions can be properly recognized with training will assist in expanding this skill's perceived credibility among these and other organizations. The study's findings can assist in ensuring that these individuals will receive micro-expression training allowing them to further enhance their skills in protecting those that they serve.

Conclusion

Research into deception detection recognition and training is still extremely limited. Research is limited to a small number of academics, while misconceptions populate the public's perceptions on deception detection, with shows such as Lie to Me having been shown to decrease viewer's ability to detect deception (Levine, Serota & Shulman, 2010; Porter & tenBrink, 2010). As a result of these issues, the field of deception detection recognition and training, of which micro-expressions are a subfield, is currently in a state of development, which is highly important to the field and international security. As the nature of security threats alter around the world, the ability to properly detect deception, micro-expressions, and threats will increasingly be an important skill set for those who provide security (U.S. GAO, 2013).

Micro-expression training efficacy still requires further study as many aspects of the training are not yet fully understood, as highlighted by this study. Previous studies had not looked at how training impacts the ability to recognize each of the seven universal emotions displayed as micro-expressions. This was addressed within the study, resulting in several important findings. For example, training, as currently implemented, was not affecting in teaching individuals how to recognize disgust and sadness micro-expressions. This suggests that providing further training on these emotions may allow all seven emotions to be recognized at a similarly high level of accuracy. Future research should address a variety of issues as discussed within the study, notably the ability to train individuals to recognize micro-expressions in virtual reality to increase the similarities and variables in which micro-expressions are displayed in situations individuals may encounter during their daily routines, thus likely enhancing the external validity of the training.

The current study adds to the empirical evidence that micro-expression recognition is a skill which can be taught, though training for micro-expression recognition still needs to be further developed to ensure that the seven universal emotions can be properly recognized by those who undertake the training. The study adds to the data on micro-expression recognition and will assist in organizations undertaking micro-expression training knowing that it is scientifically valid which was a concern of US GAO with the inclusion of micro-expression training in the SPOT program and will add to the validity of micro-expression training for military, police and security professionals.

References

Adolphs, R. (2002). Neural systems for recognizing emotion. *Current opinion in neurobiology*, *12*(2), 169-177. Retrieved from doi: 10.1016/S0959-4388(02)00301-X

Agosta, L. (2010). Heidegger's 1924 clearing of the affects using Aristotle's rhetoric, book ii. *Philosophy Today, 54*(4), 333-345. Retrieved from https://www.pdcnet.org/philtoday/Philosophy-Today

Anders, S. (2015). What are you really saying? *Physician Leadership Journal, 2*(2), 82-83. Retrieved from https://www.physicianleaders.org/publications/journal

Amazon. (2017). *Amazon Mechanic Turk*. Retrieved from https://requester.mturk.com

American Psychological Association. (2010). *Ethical principles of psychologists and code of conduct*. Retrieved from http://www.apa.org/ethics/

Ball, K., Edwards, J. D., & Ross, L. A. (2007). The impact of speed of processing training on cognitive and everyday functions. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 62*(1), 19-31. Retrieved from https://academic.oup.com/psychsocgerontology

Benitez-Quiroz, C. F., Wilbur, R. B., & Martinez, A. M. (2016). The not face: A grammaticalization of facial expressions of emotion. *Cognition*, *150*, 77-84. doi:10.1016/j.cognition.2016.02.004

Boucher, J. D., & Carlson, G. E. (1980). Recognition of facial expression in three cultures. *Journal of Cross-Cultural Psychology, 11*, 263-280. Retrieved from http://jcc.sagepub.com/content/11/3/263.short

Brown, E. C., Tas, C., & Brüne, M. (2012). Potential therapeutic avenues to tackle social cognition problems in schizophrenia. *Expert Review of Neurotherapeutics, 12*(1), 71-81. doi: 10.1586/ern.11.183

Brown, J. C., & Park, H. S. (2016). Longitudinal student research competency: Comparing online and traditional face-to-face learning platforms. *Advances in Social Work*, *17*(1), 44-58. doi: 10.18060/20870

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high quality, data? *Perspectives on Psychological Science, 6*, 3–5. Retrieved from journals.sagepub.com/home/pps

Burgoon, J., Guerrero, L., & Floyd, K. (2010). *Nonverbal communication.* New York, NY: Pearson Education.

Darwin, C., (1872). *The expressions of the emotions in man and animals*. London, UK: Murray

DeRosier, M. E., McMillen, J., Naomi, O. D., Kameny, R., & Hoffend, C. (2011). Tools to support career advancement of diverse social, behavioral, and mental health. *Journal of Online Learning and Teaching, 7*(1), 43-59. Retrieved from jolt.merlot.org/

DeWitt, A. L., (2015). Detecting deception during voir dire. *American Journal of Trial Advocacy, 39*(1), 25-50. Retrieved from https://american-journal-of-trial-advocacy.scholasticahq.com/

Dunbar, R. I. (1998). The social brain hypothesis. *Evolutionary Anthropology: Issues, News, and Reviews: Issues, News, and Reviews, 6*(5), 178-190. Retrieved from https://onlinelibrary.wiley.com/journal/15206505

Ekman P., (1977a). Biological and cultural contributions to body and facial movement. In Blacking, J. (Ed.), *The anthropology of the body* (pp. 38-84). London: Academic Press

Ekman, P., (1977b). Facial expression. In Siegman, A. & Feldstein, S. (Eds.), *Nonverbal communication and behavior* (pp. 97-126). Newark, NJ: Lawrence Erlbaum Association. Retrieved from https://www.paulekman.com/wp-content/uploads/2013/07/Facial-Expression.pdf

Ekman, P., 2001. *Telling lies: Clues to deceit in the marketplace, marriage, and politics* (3rd ed.). New York, NY: W.W. Norton.

Ekman, P. (2004). *Emotions revealed: Recognizing faces and feelings to improve communication and emotional life*. New York, NY: Times Books.

Ekman, P., & Friesen, W. (1969). Nonverbal leakage and clues to deception. *Psychiatry, 32*(1), 88–106. Retrieved from http://www.dtic.mil

Ekman, P., Friesen, W. V., & Ellsworth, P. (1972). *Emotion in the human face: Guide-lines for research and an integration of findings*. New York, NY. Pergamon.

Ekman, P., & Friesen, W. (1974). Detecting deception from the body or face. *Journal of Personality and Social Psychology, 29*(3), 288–298. doi:10.1037/h0036006.

Ekman, P. & Friesen, W. V. (1977). Nonverbal Behavior. In Ostwald, P. F. (Ed.), Communication and Social Interaction (pp. 37-46). New York, NY: Grune &

Stratton. Retrieved from https://www.paulekman.com/wp-content/uploads/2013/07/Nonverbal-Behavior.pdf

Ekman, P., Friesen, W.V., & Hager, J.C. (2002). *The Facial Action Coding System*. Salt Lake City, UT: Research Nexus eBook.

Ekman, P., & Keltner, D. (1970). Universal facial expressions of emotion. *California Mental Health Research Digest*, *8*(4), 151-158. Retrieved from http://www.paulekman.com/journal-articles/

Ekman, P., & O'Sullivan, M. (2006). From flawed self-assessment to blatant whoppers: The utility of voluntary and involuntary behavior in detecting deception. *Behavioral Sciences & the Law, 24*(5), 673–686c. Retrieved from https://onlinelibrary.wiley.com/journal/10990798

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: a meta-analysis. *Psychological Bulletin, 128*(2), 203-235 doi: 10.1037/0033-2909.128.2.203

Enquist, M., & Arak, A. (1993). Selection of exaggerated male traits by female aesthetic senses. *Nature, 361*(6411), 446. Retrieved from www.nature.com/

Field A. Discovering Statistics Using IBM SPSS Statistics. 4th ed. London: SAGE (2013).

Freina, L., & Ott, M. (2015). A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives. *eLearning & Software for Education*, *1*, 133-141. Retrieved from https://www.elseconference.eu/

Galati, D., Scherer, K. R., & Ricci-Bitti, P. E. (1997). Voluntary facial expression of

emotion: comparing congenitally blind with normally sighted encoders. *Journal of Personality and Social Psychology, 73*(6), 1363-1379. doi: 10.1037/0022-3514.73.6.1363

Gibbon, M. (2002). Doing a doctorate using a participatory action research framework in the context of community health. *Qualitative Health Research, 12*(4), 546–558. doi 10.1177/104973202129120061

Gombos, V. A. (2006). The cognition of deception: The role of executive processes in producing lies. *Genetic, Social, and General Psychology Monographs, 132*(3), 197-214. Retrieved from https://www.tandfonline.com/loi/vzpm20

Greely, H. T., & Illes, J. (2007). Neuroscience-based lie detection: The urgent need for regulation. *American Journal of Law and Medicine, 33*(2), 377-431. Retrieved from journals.sagepub.com/loi/jlm

Haggard, E. A., & Isaacs, K. S. (1966). Micro-momentary facial expressions as indicators of ego mechanisms in psychotherapy. In L. A. Gottschalk & A. H. Auerbach (Eds.), Methods of Research in Psychotherapy (pp. 154-165). New York: Appleton-Century-Crofts.

Hamilton, Ryan (2010a). *Statistical Concept Review Document* [Class handout]. Fredericton, NB: University of New Brunswick, PSYC 6003

Hamilton, Ryan (2010b). *Missing Data Handbook* [Class handout]. Fredericton, NB: University of New Brunswick, PSYC 6003

Hargrave, J. (2008). Do you speak body language? *Forensic Examiner, 17*(3), 17-22. Retrieved from www.theforensicexaminer.com/

Hara, K., Adams, A., Milland, K., Savage, S., Callison-Burch, C., & Bigham, J. P. (2018). A data driven analysis of workers' earnings on Amazon Mechanical Turk. *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI'18)*. Retrieved from https://arxiv.org/ftp/arxiv/papers/1712/1712.05796.pdf

Herman, J. M., M.Ed. (2012). Creating balance in the new age of technology. *Montessori Life, 24*(3), 36-43. Retrieved from https://amshq.org/Publications-and-Research/Montessori-Life

Hill, D. (2003). Tell me no lies: Using science to connect with consumers. *Journal of Interactive Marketing, 17*(4), 61-72. doi: 10.1002/dir.10068

Hoffman, J. (2008). Exhibition: How faces share feelings. *Nature, 452*(7186), 413. doi: 10.1038/452413a

Holmes, M. (2011). National security behavioral detection: A typography of strategies, costs, and benefits. *Journal of Transportation Security, 4*(4), 361-374. doi: 10.1007/s12198-011-0076-1

Hurley, C. M. (2012). Do you see what I see? Learning to detect micro expressions of emotion. *Motivation and Emotion, 36*(3), 371-381. doi: 10.1007/s11031-011-9257-2

Hurley, C. M., Anker, A. E., Frank, M. G., Matsumoto, D., & Hwang, H. C. (2014). Background factors predicting accuracy and improvement in micro expression recognition. *Motivation and Emotion, 38*(5), 700-714. doi: 10.1007/s11031-014-9410-9

Huxley, S. J. (1966). *A Discussion on Ritualization of Behavior in Animals and Man.*

Special issue of Philosophical Transactions of the Royal Society of London, Series B. Biological Sciences, 251, 772.

International Business Machines. (2016). IBM SPSS Statistics v23.0. Retrieved on October 22, 2016, from http://www-03.ibm.com/software/products/en/spss-statistics

Ironkey (2016). Certifications & compliance. Retrieved on 27 October 27, 2016, from http://www.ironkey.com/en-US/website/certification-and-compliance.html

Izard, C. E. (1971). *The face of emotion*. New York, NY: Appleton-Century-Crofts.

Jack, R. E., Garrod, O. G., & Schyns, P. G. (2014). Dynamic facial expressions of emotion transmit an evolving hierarchy of signals over time. *Current biology*, *24*(2), 187-192. doi: 10.1016/j.cub.2013.11.064

Kahane, G. (2008). The art of medicine: Brain imaging and the inner life. *The Lancet, 371*(9624), 1572-3. Retrieved from https://www.thelancet.com/

Kane, M., & O'Byrne, N. (2014). Deception Detection: Using Technology to Teach Credibility Assessment in Evidence Law. *Association of Atlantic Universities: Proceedings of the 2013 AAU Teaching Showcase, 17*, 62-74.

Kim, K. J., & Bonk, C. J. (2006). The future of online teaching and learning in higher education. *Educause Quarterly*, *29*(4), 22-30. Retrieved from https://www.educause.edu/

Kuhnke, E. (2012). *Body language for dummies*. John Wiley & Sons. Chichester, West Sussex, UK.

Kulwin, N (2016, July 11). *Amazon's Mechanical Turkers are college-educated*

millennials making less than minimum wage. Retrieved from https://www.recode.net/2016/7/11/12148646/amazon-mechanical-turk-college-millennials-minimum-wage

Levine, T. R., Serota, K. B., & Shulman, H. C. (2010). The impact of Lie to Me on viewers' actual ability to detect deception. *Communication Research, 37*(6), 847-856. doi: 10.1177/0093650210362686

Liu, X., Xie, L., Liu, A., & Li, D. (2015). Cognitive emotional regulation model in human-robot interaction. *Discrete Dynamics in Nature and Society,* doi: 10.1155/2015/829387

Mahalik, J. R., Locke, B. D., Ludlow, L. H., Diemer, M. A., Scott, R. P. J., Gottfried, M., & Freitas, G. (2003). Development of the Conformity to Masculine Norms Inventory. *Psychology of Men & Masculinity, 4*(1), 3-25. doi: 10.1037/1524-9220.4.1.3

Matsumoto, D. (1992). American-Japanese cultural differences in the recognition of universal facial expressions. *Journal of Cross-Cultural Psychology*, *23*(1), 72-84. Retrieved from http://www.davidmatsumoto.com

Matsumoto, D., & Hwang, H. (2011). Evidence for the training ability to read micro-expressions of emotion. *Journal of Motivation and Emotion*, *35*(1), 181-191. Retrieved from http://www.davidmatsumoto.com

McAndrew, F.T., 1986. A cross-cultural study of recognition thresholds for facial expressions of emotion. *Journal of Cross-Cultural Psychology*, 17(2), 211-224, doi: 10.1177/0022002186017002005]

Mendenhall, G. S., & Schmidhofer, M. (2013). Screening tests for terrorism. *Regulation, 35*(4), 26-31. Retrieved from http://ezp.waldenulibrary.org/login?url=http://search.proquest.com/docview/1319483983?accountid=14872

Meyer, J. (2008). Exhibition: An eye for detail. *Nature, 452*(7186), 413. doi: 10.1038/452413b

Miller, D. E. (2011). Toward a theory of interaction: The Iowa school. *Symbolic Interaction, 34*(3), 340-348. doi: 10.1525/si.2011.34.3.340

Minardi, H. (2012). Developing the dynamic emotion recognition instrument (DERI). *Nursing Standard (through 2013), 26*(50), 35-42. Retrieved from https://journals.rcni.com/nursing-standard

Minardi, H. (2013). Emotion recognition by mental health professionals and students. *Nursing Standard (through 2013), 27*(25), 41-8. Retrieved from https://journals.rcni.com/nursing-standard

Morgeson, F. P., Campion, M. A., Dipboye, R. L., Hollenbeck, J. R., Murphy, K., & Schmitt, N. (2007). Reconsidering the use of personality tests in personnel selection contexts. *Personnel Psychology, 60*(3), 683-729. Retrieved from https://us.hogrefe.com/products/journals/journal-of-personnel-psychology

Mueler, M. (2010). Competition for processing resources between emotional stimuli and foreground task in the human brain. *Romanian Journal of Experimental Applied Psychology, 1* Retrieved from www.rjeap.ro/

Nowicki, S., & Duke, M. P. (1994). Individual differences in the nonverbal communication of affect: The Diagnostic Analysis of Nonverbal Accuracy Scale. *Journal of Nonverbal behavior, 18*(1), 9-35. doi: 10.1007/BF02169077

O'sullivan, M., Frank, M. G., Hurley, C. M., & Tiwana, J. (2009). Police lie detection accuracy: The effect of lie scenario. *Law and Human Behavior, 33*(6), 530-8. doi: 10.1007/s10979-008-9166-4

Palermo, R., O'Connor, K.,B., Davis, J. M., Irons, J., & McKone, E. (2013). New tests to measure individual differences in matching and labelling facial expressions of emotion, and their association with ability to recognise vocal emotions and facial identity. *PLoS One, 8*(6) doi: 10.1371/journal.pone.0068126

Paolacci, G., & Chandler, J. (2014). Inside the Turk: Understanding Mechanical Turk as a participant pool. *Current Directions in Psychological Science, 23*(3), 184-188. Retrieved from journals.sagepub.com/home/cdp

Pearl, J., & Bareinboim, E. (2014). External validity: From do-calculus to transportability across populations. *Statistical Science, 29*(4), 579-595. doi:10.1214/14-STS486

Porter, S., & ten Brinke, L. (2008). Reading between the lies: Identifying Concealed and Falsified Emotions in Universal Facial Expressions. *Psychology Science, 19*(5), 508-514 doi: 10.1111/j.1467-9280.2008.02116

Porter, S., & ten Brinke, L. (2010). The truth about lies: What works in detecting high‐stakes deception? *Legal & Criminological Psychology, 15*(1), 57-75. doi:10.1348/135532509X433151

Porter, S., ten Brinke, L., & Wallace, B. (2012). Secrets and lies: Involuntary leakage in

deceptive facial expressions as a function of emotional intensity. *Journal of Nonverbal Behavior, 36*(1), 23-37. doi: 10.1007/s10919-011-0120-7

Pozzato, L. R. (2010). Interpreting nonverbal communication for use in detecting deception. *Forensic Examiner, 19*(3), 86-89,92-97,126. Retrieved from http://www.theforensicexaminer.com/

Ramsland, K. (2012). The man of 1,000 faces: Paul Ekman and the science of facial analysis. *Forensic Examiner, 22*(1), 65-70. Retrieved from http://www.theforensicexaminer.com/

Rinn, W. (1984). The Neuropsychology of facial expressions: A review of the neurological and psychological mechanisms for producing facial expressions. *Psychological Bulletin, 95*(1), 52-77. doi:10.1037/0033-2909.95.1.52

Rinn, W. (1991). Neuropsychology of facial expression. In R. Feldman & B. Rime (Eds.), Fundamentals of nonverbal behavior (pp. 3-70). Cambridge, England: Cambridge University Press.

Rúas-Araújo, J., Larrea, M. I. P., Alvarado, H. G., Cuesta-Morales, P., & Ratté, S. (2015). Neuroscience applied to perception analysis: Heart and emotion when listening to Ecuador's national anthem. *Revista Latina De Comunicación Social, 70*, 401-422. doi: 10.4185/RLCS-2015-1052en

Ruddall, B. H. (1999). Contemporary systems and cybernetics. *Kybernetes, 28*(8), 864-880. Retrieved from https://www.emeraldinsight.com/loi/k

Saville, A., & Balas, B. (2014). Detecting personal familiarity depends on static frames in "thin slices" of behavior. *Psychonomic Bulletin & Review, 21*(6), 1537-43.

Retrieved from https://www.springer.com/psychology/cognitive+psychology/journal/13423

Scherer, K. R., & Scherer, U. (2011). Assessing the ability to recognize facial and vocal expressions of emotion: Construction and validation of the emotion recognition index. *Journal of Nonverbal Behavior, 35*(4), 305-326. doi: 10.1007/s10919-011-0115-4

Schönenberg, M., Christian, S., Gaußer, A., Mayer, S. V., Hautzinger, M., & Jusyte, A. (2014). Addressing perceptual insensitivity to facial affect in violent offenders: First evidence for the efficacy of a novel implicit training approach. *Psychological Medicine, 44*(5), 1043-52. doi: 10.1017/S0033291713001517

Shen, X., Wu, Q., & Fu, X. (2012). Effects of the duration of expressions on the recognition of microexpressions. *Journal of Zhejiang University Science B*, *13*(3), 221-230. doi: 10.1631/jzus.B1100063

Shen, X., Sui, H., & Fu, X. (2017). The application of microexpression in the detection of deception. *Advances in Psychological Science, 25*(2): 211-220. Retrieved from http://journal.psych.ac.cn/xlkxjz/EN/volumn/volumn_197.shtml

Sieb, R. (2013). The Emergence of Emotions. *Activitas Nervosa Superior, 55*(4), 115-145. Retrieved from https://link.springer.com/journal/41470

Siever, D., C.E.T. (2012). Audio-visual entrainment: A novel way of boosting grades and socialization while reducing stress in the typical college student. *Biofeedback (Online), 40*(3), 115-124. Retrieved from http://www.aapb-biofeedback.com/?code=aapb-site

Simpson, T. W. (2011). E-trust and reputation. *Ethics and Information Technology, 13*(1), 29-38. doi: 10.1007/s10676-010-9259-x

Smith, S., & Grant, A. (2014). Facial affect recognition and mental health. *Mental Health Practice (2014+), 17*(10), 12. doi: 10.7748/mhp.17.10.12.e944

Statistics Canada (2005, February 1). Land and freshwater area, by province and territory. Retrieved from http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/phys01-eng.htm

Stewart, P. A., Waller, B. M., & Schubert, J. N. (2009). Presidential speechmaking style: Emotional response to micro-expressions of facial affect. *Motivation and Emotion, 33*(2), 125-135. doi: 10.1007/s11031-009-9129-1

Subramaniam, K., Luks, T. L., Fisher, M., Simpson, G. V., Nagarajan, S., & Vinogradov, S. (2012). Computerized cognitive training restores neural activity within the reality monitoring network in schizophrenia. *Neuron, 73*(4), 842-53. doi: 10.1016/j.neuron.2011.12.024

Svegar, D. (2011). Visual working memory capacity for emotional facial expressions. *Psychological Topics, 20*(3), 489-502. Retrieved from https://hrcak.srce.hr/psihologijske-teme

Tabachnick, B. G. & Fidell, L. S., (2007). *Using multivariate statistics* (5th ed.). Boston, MASS: Pearson/ Allyn & Bacon.

Toh, W. L., Rossell, S. L., & Castle, D. J. (2011). Current visual scanpath research: A review of investigations into the psychotic, anxiety, and mood disorders. *Comprehensive Psychiatry, 52*(6), 567-579. doi:

10.1016/j.comppsych.2010.12.005

Tran, V. D. (2014). The effects of cooperative learning on the academic achievement and knowledge retention. International Journal of Higher Education, 3(2), 131-140 doi: 10.5430/ijhe.v3n2p131

Tukey, J. W. (1953). The problem of multiple comparisons. Unpublished manuscript.

United Stated Government Accountability Office (2013). Aviation Security: TSA Should Limit Future Funding for Behavior Detection Activities. Retrieved from http://www.gao.gov/products/GAO-14-158T

Vasconcellos, S. J. L., Salvador-Silva, R., Gauer, V., & Gauer, G. J. C. (2014). Psychopathic traits in adolescents and recognition of emotion in facial expressions. *Psicologia, Reflexão e Crítica, 27*(4), 768-774. doi: 10.1590/1678-7153.201427417

Ventreli, M. R., & Simon, N. (2012). How I learned to stop worrying about liars and love microexpressions. *American Journal of Family Law, 25*(4), 143-147. Retrieved from http://www.aspenpublishers.com/product.asp?catalog_name=Aspen&product_id=9900039000&promoID=MEGAL

Vrij, A., & Mann, S. (2004). Detecting deception: The benefit of looking at a combination of behavioral, auditory and speech content related cues in a systematic manner. *Group Decision and Negotiation, 13*(1), 61-79. Retrieved from http://www.springerlink.com/openurl.asp?genre=journal&issn=0926-2644

Vrij, A. (2004). Why professionals fail to catch liars and how they can improve. *Legal*

and Criminological Psychology, 9, 159-181. Retrieved from http://www.bps.org.uk/publications/jLC_1.cfm

Vrij, A., Mann, S., & Fisher, R. P. (2006). An empirical test of the behaviour analysis interview. *Law and Human Behavior, 30*(3), 329-45. doi: 10.1007/s10979-006-9014-3

Waller, B. M., Cray Jr, J. J., & Burrows, A. M. (2008). Selection for universal facial emotion. *Emotion, 8*(3), 435-439. doi:10.1037/1528-3542.8.3.435

Wang, Y., See, J., Phan, R. C. -., & Oh, Y. (2015). Efficient spatio-temporal local binary patterns for spontaneous facial micro-expression recognition. *PLoS One, 10*(5) doi: 10.1371/journal.pone.0124674

Warren, G., Schertler, E., & Bull, P. (2009). Detecting deception from emotional and unemotional cues. *Journal of Nonverbal Behavior, 33*(1), 59-69. doi: 10.1007/s10919-008-0057-7

Wijk, R. A., He, W., Mensink, M. G. J., Verhoeven, R. H. G., & Graaf, C. d. (2014). ANS responses and facial expressions differentiate between the taste of commercial breakfast drinks. *PLoS One, 9*(4) doi: 10.1371/journal.pone.0093823

Williams, K. C., Hernandez, E. H., Petrosky, A. R., & Page, R. A. (2009). The business of lying. *Journal of Leadership, Accountability and Ethics,* 1-20. Retrieved from http://www.na-businesspress.com/jlaeopen.html

Wojciechowski, J., Stolarski, M., & Matthews, G. (2014). Emotional intelligence and mismatching expressive and verbal messages: A contribution to detection of deception. *PLoS One, 9*(3) doi: 10.1371/journal.pone.0092570

Wong, C. K. M., Yip, B. H. K., Mercer, S., Griffiths, S., Kung, K., Wong, M. C., . . . Wong, S. Y. (2013). Effect of facemasks on empathy and relational continuity: A randomised controlled trial in primary care. *BMC Family Practice, 14*, 200. doi: 10.1186/1471-2296-14-200

Williams, L. J., & Abdi, H. (2010). Fisher's least significant difference (LSD) test. Encyclopedia of research design, 218, 840-853. Retrieved from http://www.utd.edu/~Herve/abdi-LSD2010-pretty.pdf

Yamey, G. (2004). Emotions revealed: Recognising facial expressions. *Student BMJ,12* doi: 10.1136/sbmj.0404140

Yan, W., Wu, Q., Liang, J., Chen, Y., & Fu, X. (2013). How fast are the leaked facial expressions: The duration of micro-expressions. *Journal of Nonverbal Behavior*, *37*(4), 217-230. doi:10.1007/s10919-013-0159-8

Yan, W., Li, X., Wang, S., Zhao, G., Liu, Y., Chen, Y., & Fu, X. (2014). CASME II: An improved spontaneous micro-expression database and the baseline evaluation. *PLoS One, 9*(1), e86041. doi: 10.1371/journal.pone.0086041

Yaseen, Z. S., Kopeykina, I., Gutkovich, Z., Bassirnia, A., Cohen, L. J., & Galynker, I. I. (2014). Predictive validity of the suicide trigger scale (STS-3) for post-discharge suicide attempt in high-risk psychiatric inpatients. *PLoS One, 9*(1), e86768. doi: 10.1371/journal.pone.0086768

Zhu, Y., & Suzuki, N. (2016). Your face is even more surprised than you are: Evidence from facial electromyographic activity exposing the genuine surprise. *North American Journal of Psychology, 18*(1), 45-58. Retrieved from http://najp.us/