TRUE LIES: WHO CAN LEARN TO TELL?

By

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Abstract

Non-verbal cues can provide behavioural signals of deception to observers. Micro-expressions are facial cues that indicate the presence of an emotion being concealed by a deceiver. During deception, deceivers often attempt to conceal an emotion by masking it with an expression of another emotion such as a smile. Despite this, micro-expressions may be leaked during masking to reveal the hidden emotion. Nonetheless, research has shown that the majority of people recognize the occurrence of deception no better than could be expected by chance. Micro-expression detection training has been suggested to improve micro-expression detection skill that is linked to improved deception detection. The present study examined the effectiveness of the Micro-expression Training Tool (METT) in improving students' and police officers' skills in detecting masking smiles. The visual attention of trainees and untrained controls was measured via eye tracking during a pre and post test masking smile detection task. Results revealed that training did not have an effect on task performance, but practice did alter task performance. Following practice, all groups showed better detection of true smiles but not for masking smile detection. Participants' abilities to identify masked emotions and location of micro-expressions on the face varied as a function of the emotion present, as did their attention to the relevant regions of the face that contained a micro-expression. These results suggest that traditional micro-expression training is not sufficient to train observers in masking smile detection. This result has significant implications for future training protocols and many professional groups, as masking smiles are often employed during attempts at deception.

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Table of Contents

List of Tables

Name ***Page***

List of Appendices

True Lies: Who Can Learn to Tell?

Inquiry into the cues to deception and its detection has a history at least three and a half centuries long; this subject matter has been documented in early works such as Seigneur deMontaigne (1685)'s *Of Liars*, or Bulwer (1644)'s discussion of the hand movements that give away a deceptive orator. Since that time, contemporary researchers have documented multiple nonverbal cues to deception (DePaulo et al., 2003). Of these cues, facial expressions are reported to include indicators of disguised emotion during deception (Ekman & Friesen, 1982; Ekman, 2009; Ekman & O'Sullivan, 2006). Despite the presence of these cues, observers tend to have difficulty in detecting deception from facial expressions. The majority of observers can detect these cues little better than is expected by chance (Ekman & O'Sullivan, 1991; Ekman, O'Sullivan & Frank, 1999; DePaulo et al., 2003; Porter, Woodworth & Birt, 2000; Thibault, Gosselin, Brunel & Hess, 2009). This difficulty in processing and/or interpreting these cues requires further investigation. The research reported here examined observers' visual attention to and interpretation of these cues. The effectiveness of an information plus feedback-based training program in reading facial expression cues was also examined.

Cues to deception can be broadly categorized into two groups: cognition-based cues and emotion-based cues. Cognition-based cues include the absence of typical story-telling characteristics such as unstructured production, contextual embedding, reproduction of speech, and unusual details (Vrij, 2004). Cognition-based cues may also be behavioural, including limited use of illustrators such as hand movements used to illustrate story features (DePaulo et al., 2003). Emotion-based cues may include heightened pitch during speech (DePaulo et al., 2003), or nonverbal features such as incongruent facial expressions (Ekman & Friesen, 1969). The present study focused on nonverbal facial expression cues.

To fully understand the importance of facial expressions to deception, we first must understand the role emotions play in deception. Emotions may occur via two different mechanisms (Ekman, 1999). These mechanisms are differentiated by the deliberate or automatic evaluation of emotionally-relevant stimuli. The first of these mechanisms involves slower intentional evaluation of stimuli. This evaluation may influence emotions as well as behaviours by initiating, altering or suppressing one or both of them post-evaluation (Ekman, 1999). The second mechanism involves rapid, involuntary evaluation of a stimulus. This automatic appraisal mechanism may elicit emotions in response to stimuli prior to activation of the cognitive system (Ekman, 1999). This mechanism allows for rapid processing of stimuli and activation of an appropriate emotional response by avoiding higher level processing when a lower level is sufficient (LeDoux, 1991). Therefore, an emotional response may begin prior to the bearer being cognizant of what is occurring. Not all emotional experiences occur in this way, but all basic emotions can be elicited via this mechanism (Ekman, 1999; Parkinson, 1997). This automatic mechanism is particularly important to deception, as emotions may be expressed during an interaction without the conscious knowledge of the bearer (Ekman & Friesen, 1969).

Emotions can arise during lie telling in one of two ways (Ekman & Friesen, 1969). According to Ekman and Friesen (1969), emotions during lie telling can occur as a function of the telling of the lie itself or as a function of the situation surrounding the lie. In the former scenario, lie tellers experience emotions related to the *act of lying* such as fear of being caught, guilt about lying or even “duping delight” that occurs when a lie teller feels joy in fooling another. In the second scenario, lie tellers may experience emotion related to the *situation surrounding the lie*. In this case, a lie may take the form of attempts to conceal an emotion that is being experienced as a result of the situation. This kind of concealed of emotion might arise, for example, when a person is forced by social convention to be polite to someone whom they dislike. Attempts to conceal felt emotions may be belied in the facial expressions of a deceiver (Ekman, 2003; Ekman & O’Sullivan, 2006).

Facial Expressions of Emotion

Facial expressions of emotion have been theorized to serve several possible functions. The behavioural ecology view of facial expressions proposes that facial expressions have evolved under a socio-evolutionary contingency favouring two tendencies: a genetic tendency for facial displays of future behaviours, as well as a genetic tendency to attend to these facial signals (Green, 2007). By this logic, facial expressions are conceived of as a social signal that increases both parties’ chances of survival due to its association with behaviour. In contrast, appraisal theory of emotional expression describes facial expressions as a manifestation of emotion following cognitive appraisal of an emotion-eliciting situation (Frijda, 1986; Scherer, 1984a). In keeping with Charles Darwin (1864; 1998), on the other hand, the neuro-cultural view of facial expressions suggests that they are elicited by felt emotion or social obligation. In this view, the primary function of facial expressions is the involuntary expression of felt emotions that have an evolutionary origin due to their value as emotional signals to others (Green, 2007).

Facial expressions allow people to make inferences about other people's emotional states and related situational contexts. They may also allow prediction of another person's upcoming behaviour (Ekman, 1999; Mehu, Little & Dunbar, 2007). Observing facial expressions can allow us to modify our own behaviour to respond appropriately during interpersonal exchanges. For example, an expression of anger may allow us to infer that the person we are interacting with is angry; thus we may be able to predict a verbal or physical attack, modify our behaviour to attenuate the situation, or prepare for an escape.

During deceptive interactions, facial expressions may be manipulated to suppress or alter social cues available to observers (Ekman & Friesen, 1969). Emotional facial expressions can be inhibited, simulated or masked to manipulate a situation or another person (Ekman, 2009). Expressions may be inhibited in order to conceal a felt emotion, as when parents prevent themselves from showing fear in front of their child. In this case, the goal is to maintain a neutral expression during an emotional event. Expressions may also be simulated, as when a service person smiles at an unfamiliar customer. The goal here is to present an expression of an emotion when no actual emotion is experienced. Finally, an emotion can be masked by presenting another emotion in its place. In this case, the bearer attempts to conceal a felt emotion with an expression of another emotion. An example of masked emotion is when a parent conceals amusement at a naughty child's behaviour by presenting an angry expression. Negative emotions can also be masked by positive emotions. For instance, negative emotions can be concealed by smiles indicating joy (Ekman, Friesen & O'Sullivan, 2005). The present study focused on these types of masking smile expressions.

The Smile of True Enjoyment

In the late eighteen hundreds, Duchenne (de Boulogne; 1862/1990) reported the first systematic examination of genuine versus insincere facial expressions of emotion. His work laid a critical foundation for the next one hundred and fifty years of emotion-based deception research (Ekman & O'Sullivan, 2006). Duchenne (1862/1990) discovered that there are in fact two distinct types of smiles. Through measurement of musculature in the face, he found that smiles used to display genuine experiences of positive emotion routinely employ two muscles: The *zygomaticus major* and *orbicularis oculi* muscles. *Zygomaticus major* is the muscle that causes the corners of the lips to move up and out, while the *orbicularis oculi* are the muscles that cause the eyelids to tighten and the cheeks to rise, often resulting in "crow's feet" creases at the outer corners of the eyes. Duchenne found that non-genuine smiles less often produce movement of the *orbicularis oculi*.

These distinctions, originally observed by Duchenne (1862/1990), have since been re-evaluated and supported by contemporary researchers (Ekman & Friesen, 1982; Frank & Ekman, 1993). Although most people are unable to contract *orbicularis oculi* voluntarily, recent studies have revealed that there are a few who can engage this muscle at will (Gosselin, Perron & Beaupre, 2010; Krumhuber & Manstead, 2009). Therefore, the voluntary expression of a smile using both the *zygomaticus major* and *obicularis oculi* may provide its bearers with the ultimate deceptive expression; a smile that appears genuine even when it is not. For this reason, deceptive smiles that include activation of the *orbicularis oculi* were used here.

Production of Masking and Micro-expressions

Masking expressions may be used during deception scenarios as the deceiver may need to inhibit a felt emotion while producing an alternate emotional expression (Ekman & Friesen, 1969). For example, a violent offender accused of assault may need both to present an expression of pleasantness and to conceal anger towards the victim. Masking smiles tend to occur most frequently when subjects are attempting to conceal negative emotions (Ekman & Friesen, 1982; Ekman, Friesen & O'Sullivan, 1988; Porter & tenBrinke, 2008).

Ekman, Friesen and O'Sullivan (1988) examined production of masking smiles during a deceptive or honest interview. Participants were asked to deceive a blind interviewer by reporting they were watching a pleasant video while in fact watching a disturbing video (e.g., burn and amputation victims), or to honestly describe videos that were pleasant (e.g., nature scenes). The authors found that masking smiles occurred most often in the deceptive condition. Masking smiles were defined as smiles produced to conceal negative emotions. Masking expressions may contain traces of emotional "leakage" that occur when facial movements associated with a disguised emotion appear partially on the face of the bearer (Ekman, 2009; Ekman & Friesen, 1969; Porter & tenBrinke, 2008; Porter, tenBrinke & Wallace, 2012). These leakage cues, called micro-expressions, are involuntary and not always noticed by the bearer (Ekman & Friesen, 1969). The production of micro-expressions was first documented by Ekman and Friesen (1969), who found that momentary expressions of hidden emotion sometimes appear when people are trying to deceive.

Ekman and O'Sullivan (2006) describe micro-expressions as occurring in one of two ways; as a momentary flash of a full expression, or as a fragment of an expression that co-occurs with the expression the bearer wishes to present. To date, empirical evidence has only supported the existence of micro-expressions that occur as a fragment. Porter and ten Brinke (2008) completed a comprehensive examination of genuine, neutralized, simulated and masked emotional expressions from 41 encoders. They report that micro-expressions only occurred in either the upper or lower part of the face; micro-expressions *never* appeared over the entire face at one time. This finding was later reproduced by Porter et al. (2012) during another examination of micro-expression production. Ekman and Friesen (1975) have also reported that micro-expressions occur for durations of $1/5^{th}$ to $1/25^{th}$ of a second. More recently though, Porter and ten Brinke (2008) report that micro-expressions may occur for several times the duration previously reported by Ekman and Friesen (1975).

Porter and ten Brinke's (2008) results showed that micro-expressions occurred in 100 percent of encoders at least once and occurred more often during masking expressions compared to neutralized and simulated expressions. The micro-expressions that occurred during masking were all congruent with a felt emotion, suggesting that they were in fact linked to hidden emotion. Masking expressions containing micro-expressions of negative emotions were used here.

Deception and Micro-expression Detection

Difficulty in detecting deception has been found in student populations as well as professions including law enforcement agents, customs officers, psychologists, polygraphists and judges; deception detection skill for each of these groups rarely exceeds chance level (Ekman & O'Sullivan, 1991; Ekman, O'Sullivan & Frank, 1999; Vrij & Mann, 2001; Kraut & Poe, 1980). Although most of us are poor at making authenticity judgments, there are a handful of people who achieve 70 percent or greater accuracy; a level that exceeds that of chance guessing (Ekman, O'Sullivan & Frank, 1999; O'Sullivan & Ekman, 2004). Deception detection research has begun to examine what sets these experts apart from others (Bond, 2008; Ekman, 1999; 2009). These experts often work in professions requiring them to make these judgments frequently, and in which their judgments have significant consequences (O'Sullivan & Ekman, 2004). Examples of professions of expert detectors include secret service agents, federal judges and psychotherapists (O'Sullivan & Ekman, 2004). When making judgments experts often report greater reliance on nonverbal cues versus verbal cue use (Bond, 2008; Ekman, 2009).

Ekman and O'Sullivan (1991) examined detection accuracy and reported cue use of professionals including forensic division U.S. Secret Service agents; federal Central

Intelligence Agency (CIA), Federal Bureau of Investigation (FBI), National Security Agency (NSA) and armed forces polygraphists; city, county, state and federal robbery investigation officers; municipal and superior court judges; psychiatrists and students. Participant motivation to learn deception detection was inferred from their willingness to participate in seminars of various lengths (e.g., one hour participation inferred as low motivation versus two days participation as high motivation). Deception stimuli consisted of videotaped clips of the full body and face of women known to be lying or telling the truth about watching a pleasant video. The only participants achieving above chance detection were Secret Service agents, about half of whom were at least 70 percent accurate. Analyses of self-reported cue use found participants who reported using nonverbal cues, alone or with verbal cues, tended to be most accurate compared to those using only verbal cues. Similarly, participation in a one-day course in micro-expression detection showed a positive correlation between ability to detect micro-expressions and accuracy authenticity judgment.

In a second study of professionals frequently required to make authenticity judgments, Ekman, O'Sullivan and Frank (1999) identified other expert detectors. These experts included deception-interested psychologists; federal officers (e.g., CIA) chosen for their experience with demeanor and deception; as well as sheriffs selected for their reputation as excellent interrogators. These experts were compared to clinical and academic psychologists, federal judges, and a group of municipal, state and federal law enforcement agents with no particular expertise. Their task was to judge the truthfulness of videotapes of male students lying or telling the truth about a strong personal opinion (e.g., capital punishment or smoking in public spaces). Seventy-four percent of selected federal officers achieved 70 percent accuracy or higher. Fifty-six percent of both selected sheriffs and deception-interested psychologists also reached this high level of accuracy. The poorest overall accuracy was achieved by general law enforcement officers, academic psychologists, federal judges and clinical psychologists. Only 44 percent of clinical psychologists, 44 percent of federal judges, 29 percent of academic psychologists, and 22 percent of general law enforcement officers reached a detection accuracy of 70 percent or higher.

Bond (2008) examined reported cue use and visual attention of two detection experts identified out of 112 law enforcement agents. Both experts scored with 80-100 percent accuracy across two independent sessions. These two experts were the remainder of eleven law enforcement agents scoring 80 percent or more in the first session. The other nine experts were either unable or unwilling to participate in the follow-up. Both expert officers who continued were female and worked for the Bureau of Indian Affairs. The deception detection task involved judging the truthfulness of videos of paroled felons lying or telling the truth about four scenarios. The first scenario was concealment of a book in a professor's office. The second scenario was telling the truth or lying during a mock job interview. The third required felons to talk about someone they liked and someone they disliked truthfully and then deceptively. In the fourth condition they were asked to lie or tell the truth about a video on stalking cases. The expert officers verbally reported paying more attention to nonverbal cues. During the judgment task, their eye movements were recorded. Bond (2008) reported that at the moment of judgment, one expert's eyes fixated primarily on the speaker's face, while the other expert fixated primarily on the speaker's hands and arms. This pioneering study of visual attention during deception detection raises further questions about nonverbal cue use, such as which features are attended to prior to decision making and what information detectors take from these features. The small sample size makes it impossible to generalize from the findings, while the absence of a control group leaves the possibility that the attentional strategies of these experts may not differ from that of the average person.

Despite the heightened detection skill of some professionals, other professional groups with high need, interest and experience in deception detection remain at or near chance level detection (Ekman & O'Sullivan, 1991; Ekman, O'Sullivan & Frank, 1999). The relationship between experience, motivation and skill in deception detection remains inconsistent and unclear. For example, Ekman and O'Sullivan (1991) found a significant negative correlation (r = -.37) between years of job experience and accuracy in Secret Service participants and a positive correlation between these two variables in federal polygraphists (r = .35). Similarly, no significant correlation between confidence in their ability to detect lies (r =.03), or confidence in their success on the task (r =.02) was found across groups in Ekman and O'Sullivan (1991). The correlation between confidence and accuracy was non-significant for each group except the federal polygraphists (r =.22).

Micro-expressions should provide observers with indications that concealment is occurring. Micro-expressions occur as leakage of a felt emotion; therefore they can provide information regarding the authenticity, or more precisely the lack of authenticity, of a demonstrated emotion. Despite their relevance as a deception cue, micro-expressions are often difficult for untrained observers to recognize (O'Sullivan & Ekman, 2004). It is possible that these cues are too quick, too subtle or a combination of both too quick and subtle for the untrained eye (Chartrand & Gosselin, 2005). The majority of previous studies have used dynamic stimuli that confound these features of micro-expressions (Bond, 2008; Ekman, Friesen & O'Sullivan, 2005; Ekman & O'Sullivan, 1991; Ekman, O'Sullivan & Frank, 1999; Porter & tenBrinke, 2008; Warren, Schertler & Bull, 2009).

In one of the few published studies to have examined deception detection with masking smiles, Gosselin, Beaupre and Boissonneault (2002) found that children and adults were able to correctly distinguish enjoyment smiles from masking smiles containing a trace of anger. Smiles were produced by trained encoders and videotaped for presentation. Encoders were trained to produce two types of smiles: 1) An enjoyment smile characterized by activation of the *zygomaticus major* (lip corner puller) and *orbicularis oculi* (cheek raiser), and 2) A masking smile characterized by the lip corner puller, cheek raiser and lip tightener actions. All smiles were controlled for their intensity, duration and temporal dynamics. All stimuli were coded using the Facial Action Coding System (FACS; Ekman, Friesen & Hager, 2002) to ensure the presence of target cues and the control of confounding cues. Two encoders produce three smile types: An enjoyment smile, a masking smile with a micro-expression of slight intensity, and a masking smile with a micro-expression of medium intensity. Children and adults were asked to view video excerpts of people smiling, and answer whether the person was really happy or pretending to be happy. Results showed both children and adults are significantly more likely to respond really happy when the lip tightener action unit is absent. Only adults correctly identified anger as the hidden emotion with above chance level accuracy. This finding suggests that both adults and children are sensitive to masking smiles containing a trace of anger, although our knowledge of sensitivity to traces of other negative emotions is limited.

Deception Detection Training

The typically low levels of accuracy in deception detection have been argued by Vrij (2004) to be due to a lack of training about appropriate cues. However, while on the one hand training in nonverbal cues has been found to produce small to moderate improvements in accuracy (Vrij, 2000), some studies on the other hand have found that law officers' skills in deception detection is decreased or unimproved by training (Köhnken, 1987; Vrij & Graham, 1997). These inconsistencies in findings across studies are proposed to result from inconsistencies in methodology across studies in deception detection training (Frank & Feeley, 2003).

Frank and Feeley (2003) propose six challenges to be met in order to legitimately estimate the effectiveness of training: 1) Relevance of training to detectors, 2) Verification of deception cues in stimuli, 3) Adequate technique (training plus feedback) and duration of training (minimum one hour), 4) Sufficient number of stimuli persons (minimum 10), pre and post test research designs, and different stimulus persons per test, 5) Demonstration of generalizability to other deception detection tasks, and 6) Persistence of training benefits over time.

Relevance of the deception paradigm to detectors (often law enforcement), is necessary to maintain interest, attention, and motivation. For example, interrogators deal with suspects who fear punishment when the stakes for success or failure are high. The effectiveness of training may be underestimated when training does not address scenarios relevant to detectors (Frank & Feeley, 2003). Verifying the presence of cues establishes the validity of the stimuli being judged. Emotion-based nonverbal cues are indicators of deception (Ekman, 2002) that may increase both the relevance of the deception task to detectors (high stake lies), and the likelihood that observable cues are present (Frank & Feeley, 2003). Frank and Feeley (2003) define adequate training as including information about deception cues, and practice with feedback (correct or incorrect). They propose the minimum duration of training should be one hour. They also assert the only valid design for training studies is a pre and post test design. Individual differences between detectors cannot be sufficiently addressed with random assignment to groups (Frank & Feeley, 2003). Generalizability to other tasks is the fifth challenge as the goal of training is to assist professionals in real world tasks. Therefore, testing the effectiveness of training with novel deception stimuli is needed. Finally, retention of skills over time is the sixth and last challenge. The present study addressed the challenges of adequate training and duration, pre and post test design and generalizability to other tasks.

Frank and Feeley (2003) performed a meta-analysis on 11 peer-reviewed training studies that revealed a small (4%) increase in accuracy across studies. The authors examined the studies in light of their challenges: 1) Relevance to detectors was addressed by most studies; 2) Verification of the presence of deception cues was achieved by only two of the studies (Fiedler & Walka, 1993; Vrij, 1994); 3) Adequate training including feedback was used in seven of eleven studies (deTurck, 1991; deTurck, Harszlak, Bodhorn & Texter, 1990; deTurck, Feeley & Roman, 1997; deTurck & Miller, 1990; Fieldler & Walka, 1993;Vrij, 1994; Zuckerman, Koestner & Alton, 1984). In all studies, participants were given feedback regarding only accuracy (correct/incorrect); 4) Adequate training duration was reported in only two studies (Kassin & Fong, 1999; Kohnken, 1987); 5) Pre and post test designs, and 6) Demonstration of generalizability to other detection tasks were entirely lacking in the studies examined by Frank and Feeley (2003).

Factors Involved in Training Efficacy

Levine, Feeley, McCornack, Hughes and Harms (2005) argue that the process of training may moderately increase accuracy simply due to increased attention in trained participants. Levine et al. (2005) compared detection accuracy of three groups; training, bogus training and control. The training group was shown a valid deception training video containing information on empirically-validated nonverbal cues (e.g., longer response latency, speech errors, pauses in speech, adaptors). The bogus training group watched a sham training video containing information on nonverbal cues often thought to signal deception, but that research has shown have little or no association with deception (e.g., less eye contact, fast talking, increased posture shifting and increased foot movement). These two groups were compared to a no-training control group. The valid training and bogus training videos both lead to similar improvements in accuracy; bogus training produced a significant improvement compared to no-training (Levine et al., 2005). The authors suggest that the modest effects of training may reflect post training attentiveness rather than direct training benefits.

On the other hand, feedback has been reported to be a critical feature in increasing training effectiveness (Hill & Craig, 2004; Porter et al., 2000; Porter, Juodis, tenBrinke, Klein & Wilson, 2010). Different types of training were compared by Hill and Craig (2004). Students were randomly assigned to one of four nonverbal cue training groups; feedback only, deception training, deception training with feedback, or a control group. Deception stimuli used were videos of genuine and deceptive pain expressions during chronic back pain assessments. Training included descriptions and pictures of genuine pain expressions, descriptions and pictures of cues differentiating genuine from deceptive pain expressions, information on frequency, intensity, and timing of facial actions associated with pain, and information on cues specific to general deception. Feedback was given in writing following participants' judgments. The training with feedback group showed the greatest improvement in accuracy followed by the feedback group. The training only group did not differ from the control group. These findings support the importance of feedback and the insufficiency of information-only to training effectiveness. These findings contradict those of Levine et al. (2005) in demonstrating that increased attentiveness following information-only training is not as effective as training with feedback.

Porter et al. (2000) examined parole officers' accuracy in detecting deception prior to and throughout a two-day training seminar. Parole officers who took part in the seminar were also compared to three groups of students who were either given (1) feedback-only (correct/incorrect), (2) information-plus-feedback, or (3) no information or feedback. The two-day training seminar involved three main components; myth dissolution, information provision, and practice judgments with feedback (correct/incorrect). Myth dissolution involved informing participants about invalid myths regarding deception cues. Information provision involved presentation of studies on autobiographical memory, history of deception, deception in forensic contexts, verbal and nonverbal cues, fact pattern analysis, hypothesis testing, effective interviewing, as well as real-life cases where deception was detected. The information session focused heavily on verbal and nonverbal cues. Parole officers judged 12 videos on the first day [six before training (no feedback), six after training (with feedback)], and then again on the second day (six before review, six after review; all with feedback), of people lying or telling the truth. The second day was 5 weeks after the first. Officers and all student groups judged the same 24 video clips of people lying or telling the truth across four blocks of six videos. On the first block, accuracy rates from lowest to highest by group were parole officers, student controls, student information-plus-feedback, and student feedback-only. None of these groups exceeded 55 percent accuracy. By the final block, parole officers had shown the greatest improvement in accuracy (40%-76.7%). Similarly, across all post training blocks, parole officers were most accurate, followed by student information-plus-feedback and student feedback-only groups. All three of these groups were significantly more accurate than the control group.

In a three-hour training seminar, with similar training protocol to Porter et al. (2000), Porter, et al. (2010) found a modest improvement in deception detection accuracy despite a brief (3 hour) training duration compared to Porter et al. (2000). The training provided participants with current information on deception cues with particular attention to facial cues. The training program contained the same three components as Porter et al. (2000): 1) Myth dissolution, 2) information provision, and 3) practice with feedback. Myth dissolution involved debunking myths about deception cues and detection (e.g., intuition is a good measure of veracity). Information provision included information on verbal and nonverbal cues with additional emphasis on facial expression cues. Training in facial expression cues included descriptions and images of emotional expressions and their facial actions, as well as information about the absence of certain facial actions in false expressions. Mean hit rates for trainees improved at post test, while false alarm rates did not differ significantly. Signal detection analysis revealed post test sensitivity to truthful versus deceptive videos that was absent at pre test. Porter et al. (2010) provide one of the few published studies to examine the impact of training in facial expression cues on deception detection.

Micro-expression Training

Despite limited literature on micro-expression training and its application to deception detection, micro-expression training is reported to improve emotion recognition in clinical patients with schizophrenia (Russell, Chu & Philips, 2006; Russell, Green, Simpson & Coltheart, 2008). Schizophrenia is characterized by deficits in emotion recognition (Russell et al., 2006). Russell et al. (2006; 2008) trained patients using the Micro-expression Training Tool (METT; Ekman, 2002). The METT provides trainees with informational videos on facial actions associated with emotional expressions. The videos include verbal descriptions and visual displays. Trainees can then complete a practice that includes immediate feedback (correct/incorrect). The final video tutorial reviews the features of emotional expressions. After training patients showed improved emotion recognition (Russell et al., 2006) that continued to be evident up to 3 weeks later (Russell et al., 2008). Importantly, eye movements recorded as patients performed an emotion recognition task revealed a positive correlation between accuracy and attention to relevant regions of the face, as well as increased fixations and dwell times on these regions after METT (Ekman, 2002) training (Russell et al., 2008).

Matsumoto and Hwang (2011) reported improved micro-expression identification following a training protocol similar to the METT (Ekman, 2002), in both a western and non-western sample. Matsumoto and Hwang (2011) compared trained participants to untrained controls in both samples. The non-western sample showed improvement in recognizing anger, fear, disgust, contempt and sadness expressions, as well as higher ratings by colleagues on social and communication skills, after training with the Micro-expression Recognition Training Tool (MiX; Matsumoto & Hwang, 2011). The western sample also showed improved recognition of anger, fear, disgust and contempt expressions, as well as demonstrated retention of these skills 3 weeks post training (Matsumoto & Hwang, 2011). Some precautions in interpreting these findings are necessary as post-training ratings by colleagues, in the absence of pre-training ratings, may not reflect actual change in skill. The authors also suggest the need for further research examining generalization to other tasks that may better reflect real-life interpersonal judgments (Matsumoto & Hwang, 2011). The MiX (Matsumoto & Hwang,

2011) is designed with pre test, video tutorial, practice, review and post test similar to the METT (Ekman, 2002).

The finding presented above, in conjunction with those of Porter et al. (2010), suggests that METT training may prove to be an effective tool for deception detection training. This possibility is further supported by a positive correlation reported between ability to detect micro-expressions and accuracy in authenticity judgment (Ekman & O'Sullivan, 1991; Warren et al., 2009). Warren et al. (2009) found that volunteer lie detectors' abilities to detect emotion-based lies were positively correlated with their performance on the Subtle Expression Training Tool (SETT; Ekman, 2002). The SETT uses a similar training protocol to the METT but uses only one stimulus person to demonstrate all seven emotions (i.e., anger, sadness, happiness, fear, surprise, disgust and contempt). Unlike the METT, the SETT trains participants to identify small facial movements that may appear in one region of the face such as the brows, cheeks, nose, or mouth (https://face.paulekman.com/face/products.aspx). Deception stimuli were video clips of people lying or telling the truth about an unemotional video (Hawaiian beach) or an emotional video (Surgical procedures). METT performance was not correlated with ability to detect emotional or unemotional lies. The results of this first study on the generalizability of SETT and METT training for deception detection suggest that some facial cues to deception may fail to be detected by observers and the feature of subtlety may be crucial to success.

The current study examined the generalizability of the METT to the detection of masking smiles that contain micro-expressions of negative emotions with a pre and post test design. This study was also one of the few to date that used deception stimuli carefully created, verified and controlled for the presence and intensity of relevant deception cues. Use of static stimuli and eye-tracking allowed for close examination of the role of cue subtlety in performance on deception detection tasks.

Past Limitations

In summary, the current literature on deception cues and training has faced certain limitations, some of which were addressed by the present study. Current literature on the attentional and perceptual processes associated with detection of deception cues is relatively absent. Bond (2008) offers one of the few studies to use objective measurement of attention during a detection task by measuring eye movements, although participant numbers were insufficient ($n = 2$). Further research using eye tracking to measure visual attention during such tasks is needed to better understand which cues observers attend to, and gain relevant information from during these judgments.

Similarly, observers' abilities to explicitly identify the presence and location of micro-expressions are not well documented. Although research has shown that participants who report using nonverbal cues such as facial expressions achieve higher accuracy, these reports are retrospective after completion of a task (Porter et al., 2000; Ekman & O'Sullivan, 1991). Accuracy in micro-expression detection is reported as positively correlated with deception detection accuracy (Ekman & O'Sullivan, 1991), but there is little empirical evidence to support the assumption that observers are aware of the presence of micro-expressions during these tasks. Future research needs to examine participants' reports on the location of cues and concealed emotions identified while making judgments of facial expressions containing micro-expressions. This information would contribute further to our understanding of observers' perceptions and interpretations of these cues.

A similar limitation is brought about by the use of stimuli that are ecologically valid (e.g., videos of people lying) but not carefully controlled for cue intensity or non-target cues (Bond, 2008; Ekman & O'Sullivan, 1991; Ekman, O'Sullivan & Frank, 1999; Porter et al., 2010; Porter et al., 2000). Potential variations across stimuli and cues make it impossible to determine which features and cues decoders are sensitive to. Further research using stimuli carefully controlled for the presence of only target cues will facilitate greater understanding of the role of these cues and their features in deception detection (see for example Gosselin, Beaupré & Boissonneault, 2002).

The role of experience, confidence and motivation has continued to be inconsistent in the deception detection literature. Past research reports work-related experience in deception detection as being at times positively correlated with accuracy, while at other times being negatively correlated or uncorrelated with accuracy (Ekman & O'Sullivan, 1991; DePaulo, 1986; Porter et al., 2000). Police officers and other law enforcement agents are often employed in these studies (Bond, 2008; Docan-Morgan, T., 2007; O'Sullivan & Ekman, 2004; Porter et al., 2000; Mann, Vrij & Bull, 2004; Vrij & Mann, 2005), as veracity judgments form an integral part of their professional lives. Motivation has primarily been inferred from willingness to participate in deception detection seminars and related activities (Ekman & O'Sullivan, 1991; Ekman, O'Sullivan

& Frank, 1999), but has never been quantitatively assessed based on self-ratings. Such self-ratings may provide a more precise measure of motivation and may provide a clearer picture of its role in deception detection. The present study examined motivation both as inferred by current group membership (i.e., police officer versus student) and as reported by self-rating on a questionnaire.

Limitations in training research as outlined by Frank and Feeley (2003) include insufficient training protocols (min. one hour including practice with feedback), the absence of pre and post test designs, inclusion of control groups for comparison and examination of the generalizability of the training to related detection tasks. These limitations were addressed by the present study. Due to time constraints, we were not able to address all of the limitations and challenges set forth by Frank and Feeley (2003).

Research Contributions

This research sought to address three issues relevant to the detection of emotion-based deception: 1) Visual attention strategies and accuracy in detecting micro-expressions from masking smiles, 2) the generalizability of micro-expression training (METT; Ekman, 2002) to a masking smile detection task, and 3) the role of experience, confidence and motivation in detection accuracy.

Static images of masking smiles containing a micro-expression of another emotion such as anger, disgust, sadness and fear were used as stimuli in order to examine decoders` abilities to detect micro-expressions when they remained present for the duration of judgment. In this way the subtlety feature of these expressions was isolated to allow a clearer picture of its role in micro-expression detection. All smiles contained both the activation of the *zygomaticus major* (upturned lips) and the *orbicularis oculi* (crow's feet). Therefore, the only cue to distinguish smiles was the presence or absence of a micro-expression.

Visual attention strategies were recorded with an eye-tracking device before and after training. Eye tracking allows for objective measurement of the allocation of attention during cognitive tasks – in this case deception detection (Rayner, 1998; 2009). Micro-expressions have often been reported to be difficult for untrained observers to detect (Ekman, O'Sullivan & Frank, 1999; Ekman & Friesen, 1969; Ekman, 2009). Eye movement recording during a micro-expression detection task allow more objective measures of the attentional strategies and cues used. The proportion of time spent on micro-expressions was measured during pretest and post test. If participants learn to pay attention to the cues, more attention should be identifiably allocated to those cues (Rayner, 2009).

Participants were also asked to interpret verbally what they saw in order to explore explicit knowledge of emotional cues. The stimuli employed were carefully created to ensure the presence of micro-expressions of anger, fear, disgust, and sadness. When participants made a judgment that the smile they were observing was not authentic, they were asked to identify another emotion that might have been expressed. They were also asked to identify which region of the face helped them to make their judgments after all responses. Their responses were examined as a function of their eye movements. This comparison looked at the relationship between implicit cognition (i.e., eye-movements) and explicit knowledge (i.e., self-report). It was expected that, before training, participant accuracy in identifying the emotion present and micro-expression zone would not exceed chance guessing. After training, it was expected that all participants would show moderate improvement in correctly identifying the emotion present and relevant zone.

The present study also addressed some of the challenges proposed by Frank and Feeley (2003), such as sufficient training with feedback, pre and post test design, inclusion of a control group, and a test of generalizability to other detection tasks. The METT (Ekman, 2002) was used to train participants in micro-expression detection. The METT includes information as well as immediate feedback; it takes up to an hour to complete. Before and after training, participants completed pre and post test judgments of masking smiles. The METT trains participants to detect micro-expressions that occur as brief, rapid full expressions (Ekman & O'Sullivan, 2006). For example, during practice in distinguishing micro-expressions of anger, trainees were presented first with a neutral expression, followed by a rapid flash (1/25th of a second) of a full anger expression, which then returned to neutral. We examined whether the skills learned during METT training were generalized to decoding of the more empirically-supported (Porter & tenBrinke, 2008; Porter et al., 2012) trace micro-expressions that co-occur with an alternate expression. A smile that contains a trace of anger in the eyebrows is an example of this type of micro-expression. It was expected that after METT training all participants would attend more to regions of the face that contained micro-expressions when viewing masking smiles. For example, while viewing a masking smile with a micro-expression of fear in the eyebrow region, they were expected to attend more to the eyebrow region after training compared to before training. Specifically, it was expected that the greater the proportion of time allocated to zones containing micro-expressions, the greater the accuracy in correctly identifying the expression as “truly happy” or “pretending to be happy”.

Finally, the present study sought to better elucidate the roles of experience, confidence and motivation in detection skill. Motivation has always been inferred by participants’ chosen career or willingness to participate in deception seminars or trainings of various lengths (Ekman & O’Sullivan, 1991; Ekman, O’Sullivan & Frank, 1999). In the present study, participant motivation was measured in two ways; as inferred by their job and as rated on a self-report questionnaire. Law enforcement officers were inferred to have the highest experience and motivation in this study, as deception detection is an important element of their profession. Law enforcement officers were compared to university students who were expected to have an average level of interest and motivation as would be expected in the general population. To control for practice effects, we also included a student control group who did not participate in the training. Regardless of group assignment, motivation, confidence and interest were measured by a self-report questionnaire. One the one hand, it was expected that although no group difference should be expected at pre test, given that research has shown law enforcement officers do not differ from the general population (Ekman & O’Sullivan, 1991; Porter et al., 2000), law enforcement officers may acquire more from training, as a result of heightened motivation, making them more accurate at post test. We expected that experience and confidence would not be correlated with accuracy as previously reported by Ekman and

O'Sullivan (1991). Participants' levels of motivation, on the other hand, were expected to be positively correlated with accuracy at post test. This expectation was based on prior research demonstrating the correlation between self-rated motivation (questionnaire) and learning, as demonstrated by academic success (Goodman et al., 2011).

Hypotheses

In summary, our first hypothesis was that all participants would achieve at or near chance accuracy in recognizing smiles as happy or not happy at pre test, regardless of group membership, while at post test, only training participants would show an increase in accuracy on this task. Our second hypothesis was that the law enforcement officer group was expected to show the greatest improvement at post test across tasks (see other tasks below) compared to student trainees and student controls. Third, experience and confidence were not expected to be correlated with accuracy across tasks, although motivation was expected to be positively correlated with accuracy across tasks at post test. In terms of visual attention, our fourth hypothesis was that at post test all training participants were expected to spend more time looking at the target zones of the face that contained micro-expressions, while control participants were not expected to show any change in viewing times for target zones. The fifth hypothesis was that viewing time of target zones was expected to be positively correlated with accuracy across tasks at post test, but not pre test. Finally, at post test training participants, but not controls, were expected to improve in their identification of emotions present in masking smiles and target zones of micro-expressions. The methodology employed to explore these hypotheses is described in the following section.

Method

Participants

Thirty-six undergraduate psychology students from Laurentian University and 15 law enforcement officers from The Sudbury Regional Police Force (*n*=14) and Ontario Provincial Police Force (*n*=1) participated in this study. Two police participants' data was unusable due to program malfunction. Ten student participants' data were also not used for the final analyses; one dropped out prior to study completion, six had unusable data due to program malfunction, and three were removed to provide even group numbers for analyses. The three participants removed were selected based on calibration levels of the eye-tracking system that were above optimal levels (> 1 degree).

Participants were all recruited voluntarily and signed consent forms prior to beginning the experiment. All student participants were recruited in exchange for extra course credit and randomly assigned to two groups: student training (*n*=13; mean age=20.61, *SD*=2.43) and student control (*n*=13; mean age=22.15, *SD*=6.23). Both student groups consisted of 3 males and 10 females. Police participants were voluntarily recruited through contacts with their agencies (*n*=13; mean age=36.77, *SD*=8.47). All police participants took part in the training. The police group had a mean 3.85 years (*SD*=1.77) of experience in policing. The police participant group consisted of 9 males and 4 females.

Materials

Stimuli. Ninety-six photographs of smiling faces were presented. Each photograph contained either an authentic smile or a masking smile containing traces of a negative emotion (anger, fear, disgust, sadness; see Appendix A). Photographs were coded using the Facial Action Coding System (FACS) developed by Ekman and Friesen (1978). The FACS distinguishes 44 facial action units that are movements of the facial muscles associated with visible changes in the face. The FACS rates intensity of expression on a five point scale (A to E) with “A” being very slight intensity and “E” being extreme intensity.

Six models (3 males, 3 females) were used as stimulus persons for photographs and were trained by a registered FACS expert to produce each of the different types of smiles following the FACS criteria. First, a training session was held for the models. The trainer first verbally described each facial action and demonstrated the desired expression with photographs. Models were then instructed to practice each facial movement in a mirror and were given feedback by the FACS expert. Following supervised practice, the models were given an information booklet and sent home to practice. Next, the models returned to the laboratory where they were each photographed while producing enjoyment smiles and masking smiles under the guidance of the FACS trainer. Masking smiles were used to mask four negative emotions which were anger, sadness, fear, and disgust. Anger and sadness expressions were created twice using two distinct combinations of action units. Therefore, the final photograph array included seven types of smiles; two anger smiles, two sadness smiles, one happy smile, one disgust smile, and one fear smile. For each type of smile, four photographs of different models were chosen.

Four happy smiles were selected for use in this study. Happy smiles are distinguished by two action units: the lip corner puller (AU12) and the cheek raiser (AU6) (Ekman & Friesen, 1982). The lip corner puller is marked by stretching of the corners of the lips towards the cheekbones. The cheek raiser is marked by the lifting of the cheeks towards the eyes causing crow's feet at the corner of the eyes and bulges beneath the lower eyelids.

Eight anger masking smiles were selected. Four of these anger smiles contain cues of anger in the lower face region. These smiles are marked by 3 action units: the lip corner puller (AU12), the cheek raiser (AU6), and the lip presser (AU24) (Ekman & Friesen, 1975; Gosselin, et al., 2002). The lip presser presses the lips together causing them to tighten and narrow. The remaining four anger smiles contained cues to anger in the upper face region. These smiles contained 3 action units: the lip corner puller (AU12), the cheek raiser (AU6) and the brow lowerer (AU4) (Ekman & Friesen, 1975). The brow lowerer lowers the eyebrows and pulls them together.

Eight sadness masking smiles were selected. Four sadness smiles contained sadness cues in the lower face. These smiles were distinguished by 3 action units: the lip corner puller (AU12), the cheek raiser (AU6), and the lip corner depressor (AU15) (Ekman & Friesen, 1975). The lip corner depressor pulls the corners of the mouth down. The remaining four sadness masking smiles contain cues to sadness in the upper face.

These smiles are distinguished by 4 action units: the lip corner puller (AU12), the cheek raiser (AU6), the inner brow raiser (AU1) and the brow lowerer (AU4) (Ekman & Friesen, 1975). The inner brow raiser lifts the inner corners of the eyebrows toward the forehead in the absence of lifting in other regions of the eye and eyebrow.

Four fear masking smiles were used. These smiles are distinguished by 5 action units: the lip corner puller (AU12), The cheek raiser (AU6), the inner brow raiser (AU1), the outer brow raiser (AU2) and the brow lowerer (AU4) (Ekman & Friesen, 1975). The outer brow raiser lifts the outer corners of the eyebrows toward the forehead.

Four disgust masking smiles were selected. These smiles are marked by 3 action units: the lip corner puller (AU12), the cheek raiser (AU6) and the nose wrinkle (AU9) (Ekman & Friesen, 1975). The nose wrinkler is distinguished by lowering of the inner corners of the eyebrows while lifting the nose and upper lip toward the eyebrow causing the skin along the side of the nose to wrinkle as it pulls upward.

Photographs were selected and rated by two certified FACS coders. Inter-rater agreement for all photographs used in this experiment was 100 percent.

Apparatus. Stimuli were presented on a 21-inch VIEW-Sonic CRT monitor. Stimuli photographs were presented on two monitors: one for participant judgment and one for experimenter observation. Eye movements were measured via infrared eye tracking using an SR Research Ltd. Eyelink II system. This system has a high accuracy (<0.5 degrees) and a high sampling rate (500 Hz). The eye tracker device consists of three miniature cameras that are mounted onto a padded headband. Two cameras, located below the eyes of the participant, are used to measure the position of the eyes on the display screen every two milliseconds. The cameras are carefully positioned so as not to interfere with the participant's view of the stimuli. The third camera that is integrated directly into the headband is a head-tracking camera that allows precise tracking of the participant's point of gaze. Throughout the task, the participant's eye position was monitored by the experimenter with a cursor superimposed on the images presented on the experimenter's screen. The Eyelink II transfers information via Ethernet link from the headband to sensors on the computer monitor allowing tracking of eye movements to be recorded in real time. A distance of approximately 60 centimeters (cm) between the participant and stimuli was maintained via a chin rest. Prior to beginning the experiment, the cameras were calibrated for each participant to 1.0 or below using a 9-point calibration system.

Training system. The Micro Expression Training Tool (METT) created by Ekman (2002) was used to instruct trainees in detection of micro-expressions. METT is comprised of three video training sequences: video instruction, practice with feedback and video review. Prior to training, users took a pre test of micro-expression detection consisting of 14 randomly presented micro-expressions containing two expressions of seven emotions (anger, fear, disgust, surprise, sadness, happiness and contempt). Scores are given as a percentage based on number of correct responses.

The initial video instruction presents slow-motion videos sequences of four pairs of commonly confused emotional expressions. These pairs are anger/disgust, happy/contempt, fear/surprise and fear/sadness. A recorded commentary compares and contrasts the expressions as videos of each expression are presented. Trainees are instructed to focus their attention on the verbal descriptions as well as the visual demonstration. Following the video instruction, a practice sequence is presented that contains 28 micro-expressions. The faces are presented in a neutral state and then flash a micro-expression for 1/25th of a second before returning to neutral. Throughout the practice sequence, emotion labels are visible at all times. Trainees proceed through training and practice at their own pace, and are provided with feedback from the experimenter when requested. Following the practice sequence, a video review is presented. This sequence reviews the information given in the initial video instruction sequence using different faces to demonstrate the fourteen expressions. Following the video review, trainees are given a post test of micro-expression detection with novel models following the same format as the pre test. Scores are given in the same manner as used in the pre test.

Control task. Following the masking smile pre test, the control group completed the Nelson Denny Reading Test (NDRT; Brown, Fishco & Hanna, 1993). This test was selected as an unrelated cognitive task of comparable length and difficulty to that of the METT training. The NDRT is a standardized test of vocabulary, reading comprehension and reading rate for students from Grade 9 through adulthood. The test began with an 80 questions vocabulary section where test takers were presented with a vocabulary word embedded in a sentence to be completed with one of five response options (i.e. "A *chef* works with... a) bricks b) music c) clothes d) food e) statues"). The vocabulary section had a time limit of 15 minutes. The reading comprehension section was completed last. It consisted of seven reading passages and a total of 38 questions, with five response options, regarding the content of the passages (e.g., “How old was Keats when his mother died? a) Twelve b) Thirteen c) Fourteen d) Fifteen c) Sixteen”). This section had a 20 minute time limit. The first minute of testing was used to record reading rate. Participants were asked to read at their normal speed and mark their reading position once time was called.

Questionnaire. Following testing, all participants completed a short series of questions related to the relevance of authenticity judgments in their lives. Students and law enforcement agents answered 16 questions regarding demographic information, confidence in their ability to read facial expressions for authenticity, and motivation to develop this ability (See Appendix B). Participants were asked five demographic questions regarding their age, sex, job title, and years of job experience (field and current job role). Participants were asked to rate one statement about their experience with judging others’ sincerity (e.g.,”I frequently need to judge the sincerity of other people in my work”). They were also asked to rate two statements about their confidence level (e.g., “Before taking part in this study, I was good at reading other people’s facial expressions”). They were also asked to rate seven statements about their motivation (e.g., “Learning to judge the sincerity of facial expressions will help me do my job better”). All ratings were done on a 9-point Likert scale (1= strongly disagree, 9=strongly agree).

Procedure

All participants were given a 30 minute masking smile pre test and 30 minute masking smile post test. Trainees completed the METT system training protocol between masking smile pre and post tests. Controls completed a distraction/practice task of similar length to the METT training between masking smile pre and post tests. Masking smile pre and post tests involved presentation of a series of photographs of facial expressions in that participants were asked to distinguish the authenticity of the happy expression, and identify other emotions they perceived to be present in the expression.

Masking smile pre test. During the masking smile pre test, participants were seated in front of a computer monitor and fitted with the Eyelink II eye tracking headband. Prior to beginning the experiment, the Eyelink II was calibrated and validated to specifications. Participants were then presented with photographs of smiling faces one at a time. After presentation of the initial photograph, participants were asked if they felt that the person in the photograph was truly happy or pretending to be happy (Gosselin et al., 2002; Miles & Johnston, 2007). If participants answered "truly happy" to this question they were then asked which part of the face helped them to make this decision. If participants answered "pretending to be happy" to the first question they were then asked if they thought the person in the photograph was feeling another emotion. If they answered "no" to this question they were then asked which part of the face helped them make their decision. If they answered "yes" to the second question they were shown the photograph with a selection of emotion words (anger, shame, fear, sadness, disgust, guilt, surprise, interest, contempt, other) and asked to pick which emotion they thought the person in the photograph was feeling. After selecting an emotion, participants were then asked which part of the person's face helped them make their decision. This procedure was used for all 96 photographs and all responses were given verbally and recorded by the experimenter (see Appendix C for example of image presentation).

Training group. Following the masking smile pre test, trainees (13 undergraduates, 13 law enforcement officers) were given a 5 minute break and then began METT training. Trainees were seated in front of a computer monitor with computer mouse and instructed to proceed through the video training program at their own pace. They were told to pay attention to both the verbal instructions and the visual aids presented in the video training. Once trainees verbalized that they understood and were ready to begin, the METT program was started. Prior to the training segment of the METT system, a short pre test of micro-expression judgment was given. The METT pre test provided trainees with a percentage accuracy score. Following the METT pre test, trainees initially viewed the video instruction segment and then began the practice sequence where they were presented with 28 neutral faces that flashed a micro-expression and then returned to neutral. Trainees could see emotion labels at all times throughout the practice and used the mouse to select the emotion they thought had been present in the micro-expression. If the answered correctly they would proceed to the next image. If they answered incorrectly they would be given the option of viewing the flashed micro-expression again or viewing the micro-expression as a static image. After correctly identifying the expression the participant could then move on to the next image. After completing the practice sequence, trainees watched a video review of the initial instructions that used different reference faces for demonstration. Following review, trainees completed a METT post test of micro-expression judgments following the same format as the METT pre test.

Control group. Following the masking smile pre test, controls (15 undergraduates) were given a 5 minute break and then began the Nelson Denny Reading Test (NDRT). Control participants were moved to a sound-proof room with a large desk and seated in a chair. They were instructed that they would be taking a reading test that consisted of two separate sections, and that each section was timed. The vocabulary and reading comprehension sections of the NDRT were briefly described to participants. They were instructed on how to complete the response sheet and then completed the practice questions at the beginning of the booklet. Prior to beginning the test, participants were invited to ask questions.

Participants then began the vocabulary section of the NDRT and were given 15 minutes to complete it. Following completion of the vocabulary section, participants were given a brief review of the instructions for completing the reading comprehension section and invited to ask questions. Participants then began the reading comprehension section and were given 20 minutes to complete it. At the beginning of the section, after reading for one minute participants were asked to mark their current reading position on the booklet and then continue reading. After completion of the NDRT participants completed the masking smile post test.

Masking smile post test. After training and the control task, all participants were given a 5 minute break and then began the masking smile post test. The masking smile post test was presented exactly as the masking smile pre test described above.

The outcomes of this testing and training protocol are described in detail in the following paragraphs.

Results

Our first and second hypotheses were initially examined. Participants were all expected to perform at chance level in identifying smiles as happy or not happy at pre test, and only training participants were expected to improve at post test. Analyses of decoders' accuracies in identifying smiles as truly happy or pretending to be happy were examined between groups. Decoders' rates of responding "really happy" dependent on the type of smile were also examined to clarify participant response patterns. Our third hypothesis, regarding the expectation that participants' experience and confidence would not be correlated with accuracy, but motivation to develop deception detection skill would be positively correlated with accuracy in recognizing smiles as happy or not happy was analysed. Eye tracking data was then examined. The proportion of time spent in target zones as a function of test time and group was examined to explore our fourth hypothesis that training participants, but not control participants, would show an increase in time spent viewing target zones at post test. An analysis of the relationship between proportion of viewing time and accuracy was done to examine our fifth hypothesis that viewing times would be positively correlated with accuracy at post test. Finally, our sixth hypothesis that accuracy in explicitly identifying the target emotion and zones for masking smiles would improve at post test was analysed.

Eye movement data were coded using the SR Research Eyelink II Data Viewer program that presents the number of fixations and dwell times in each zone. Eye movement data were used to determine the proportion of time spent in zones containing relevant emotion cues for each type of smile, and compared at pre and post test. Zones of interest for each type of smile are as follows: the eyebrow zone for fear, sadness-eyebrow and anger-eyebrow smiles, the mouth zone for sadness-mouth and anger-mouth smiles, the nose zone for disgust smiles, and the eye and mouth zones for enjoyment smiles. For most analyses, the significance level was set to .05, with the exception of simple effects analyses for which the correction of Dunn was made.

Accuracy

Proportion of accurate responses. The proportion of accurate responses for two smile types ("truly happy" and "pretending to be happy") was calculated by dividing the number of times a participant gave an accurate response by the number of times each smile was shown. Participants were expected to answer "truly happy" for the happy smile and "pretending to be happy" for all other smiles (angerbrow, angermouth, sadbrow, sadmouth, fear, disgust). Table 1 shows that, at pre test, participants' level of accuracy was greater than chance for all but angerbrow smiles and declined at post test for all but happy smiles, which was contradictory to our first hypothesis. At pre test, participants gave the greatest number of accurate responses for fear smiles compared to all other smile types, while giving the least number of accurate responses for angerbrow smiles compared to all other smile types. A similar pattern of accuracy is evident at post test, with the exception that the number of accurate responses for fear smiles was no longer greater than those for happy smiles. Furthermore, participant accuracy in identifying angerbrow smiles as “pretending to be happy” decreased significantly from pre to post test. On the other hand, participant accuracy for happy smiles (“truly happy”) increased from pre to post test. A mixed-design ANOVA with smile type (angerbrow, angermouth, sadbrow, sadmouth, fear, disgust, happy) and test type (pre, post) as within subject factors and group (police, student training, student control) as a between subject factor revealed a significant main effect for smile type [$F(6, 31) = 61.97$, η_p^2=.92]. No main effects were found for test type ($F < 1$) or group [$F(2, 36) = 1.06$, p=.36.]. A significant interaction between smile type and test type was also found [$F(6, 31) = 4.93$, η_p^2=.49]. No other significant interactions were found ($F < 1$). Significant simple effects of smile type were found at pre test [F(6, 456)=13.15] and at post test [F(6, 456)=18.26]. Tukey post hoc tests revealed that there was a significant difference between fear smiles and all other smiles at pre test. Angerbrow smiles were also significantly different than all other smiles at pre test. No other significant differences were found between smile types at pre test. At post test, Tukey post hoc tests showed that angerbrow smiles remained significantly different from all other smile types, while fear smiles remained significantly different from most other smile types with the exception of happy smiles. Significant simple effects of test type were also found for angerbrow smiles between pre and post test [F(1, 266)=4.51] and for happy smiles [F(1, 266)=13.87]. No significant differences were found for any of the other five smile types (angermouth, disgust, fear, sadbrow, sadmouth; $F \leq 2.46$).

The lack of main effects for test type and group in our analyses of accuracy in recognizing smiles as happy or not happy was counter to our second hypothesis expecting training participants would show improved accuracy at post test and that law enforcement officers would show improvement distinctly greater than that of student participants.

Table 1
Proportion of Accurate Responses by Smile Type at Pre/Post Test

		Smile Types						
		Happy	Anger brow	Anger mouth	Disgust	Fear	Sad brow	Sad mouth
	Proportion of accurate responses							
	Mean	.72	.58	.73	.77	.94	.75	.73
Pre	SD	.23	.16	.18	.20	.14	.23	.24
	Mean	.85	.50	.68	.75	.89	.74	.69
Post	SD	.20	.19	.23	.26	.22	.24	.26
	Proportion "truly happy" responses							
	Mean	.72	.42	.27	.23	.06	.26	.27
Pre	SD	.23	.16	.18	.20	.14	.23	.24
	Mean	.85	.50	.32	.25	.11	.25	.31
Post	SD	.20	.19	.23	.26	.22	.24	.27

Proportion of "truly happy" responses. In line with previous studies, data were also examined in terms of the proportion of "truly happy" responses (Gosselin, et al., 2002). The proportion of "truly happy" responses was calculated for each type of smile by dividing the number of times a participant answered "truly happy" with the number of times each smile was presented. Table 1 displays the proportion of “truly happy” responses for all smile types at both pre and post test. A mixed-design ANOVA with smile type (angerbrow, angermouth, sadbrow, sadmouth, fear, disgust, happy) and test type (pre, post) as within-subject factors, and group (police, student training, control) as between subject factors, revealed a significant main effect for smile type [$F(6, 31) = 79.00$, $\eta_p^2 = .94$]. Tukey post-hocs revealed that happy and angerbrow smiles were rated at “truly happy” significantly more often than all other smiles. Fear smiles on the other hand were rated as “truly happy” significantly less often than all other smile types. A main effect of test type [$F(1, 36) = 7.19$, $\eta_p^2 = .17$] was also found. Participants tended to answer truly happy significantly more often at post test than at pre test. No main effect was found for group ($F < 1$). No significant interactions were identified ($F \leq 1.56$). These analyses demonstrate a similar pattern of responses as the accuracy analyses described previously.

Association of experience, confidence, motivation and accuracy. Our third hypothesis was that experience and confidence would not be associated with accuracy in recognizing smiles as happy or not happy, but motivation would be associated with accuracy on this task at post test. To examine this relationship, Pearson correlations were used to compare proportion of experience, proportion of confidence, proportion of motivation and accuracy rate at pre and post test. In support of our expectations for experience and confidence, there were no significant correlations between proportions of experience and confidence with accuracy in recognizing smiles as happy or not happy. In contrast to our expectation for motivation, there was also no correlation between proportion of motivation and accuracy at either pre or post test. All correlations are presented in Table 2.

Table 2 shows that none of the correlations were significant. It is interesting to note the negative trend for experience and motivation, as well as the decrease in association from pre to post test for all variables. Nonetheless, none of these variables were significantly related to participant performance when asked to recognize smiles as happy or not happy.

Table 2
Correlation of Experience, Confidence and Motivation with Accuracy at Pre/Post Test

	Accuracy	
	Pre test	Post test
	Pearson Correlations	
Experience	-.19	-.09
Confidence	.22	.01
Motivation	-.23	-.14

***None of the presented correlations reached significance at the .05 level.*

Eye Movements

Proportion of viewing time. Our fourth hypothesis predicted that at post test training participants but not control participants would spend more time viewing target zones of masking smiles that contained micro-expressions. Proportion of viewing time was calculated by dividing the time spent viewing a zone (eye, mouth, nose, brows) by the total viewing time for each participant. Proportion of viewing time for each zone was examined separately for each smile type that contains a micro-expression in that zone.

A first analysis was computed for Disgust for which the micro-expression was located in the nose area. Disgust smiles showed a decrease in proportion of viewing time from pre test (*M*=.32, SD=.13) to post test (*M*=.09, SD=.07). A repeated measures ANOVA with test time (pre, post) as a within-subject factor and group as a between-subject factor (police, student training, control) found a main effect of test time [$F(1, 36) = 87.49$, $\eta_p^2=.71$]. No effect of group was found ($F < 1$).

Proportion of viewing time in the eyebrow zone for angerbrow, sadbrow and fear smiles was then examined. Table 3 shows that proportion of viewing time in the eyebrow zone decreased significantly from pre to post test. A mixed-design ANOVA for proportion of viewing time in the eyebrow zone with smile type (angerbrow, sadbrow, fear) and test time (pre, post) as within subject factors and group (police, student training, control) as between-subject factors revealed no main effects ($F \leq 1.40$). Although a significant interaction between smile type and test time [$F(2, 34) = 5.11$, $\eta_p^2=.23$] was found, no other significant interactions were identified ($F \leq 2.38$). Simple effects were significant for smile type at post test [$F(2, 151) = 4.09$] but not at pre test [$F(2, 151) = 2.30$]. Tukey post hoc tests for post test revealed that participants spend more time looking at the eyebrows for anger than for sadness. Further analysis revealed a significant effect of test time for sadbrow smiles [$F(1, 113) = 4.66$], but no effect for angerbrow smiles [$F(1, 113) = 1.10$, $p=.30$] or fear smiles ($F < 1$). A third analysis was computed for smile types for which the micro-expression was located in the mouth area (angermouth and sadmouth). Table 4 shows that the proportion of viewing times in the mouth zone was greater for sadmouth smiles compared to angermouth smiles. A repeated measures ANOVA with smile type (angermouth and sadmouth) and test time (pre, post) as a within-subject factors and group (police, student training, control) as a between-subject factor revealed a main effect for smile type [$F(1, 34) = 16.45$, $\eta_p^2=.33$]. No effects of test time [$F(1, 34) = 2.59$, $p=.12$] or group [$F(1, 34) = 1.50$, $p=.24$] were found. There were no significant interactions.

Table 3
Proportion of Viewing Time (ms) in Mouth Zone at Pre/Post Test

		Smile Types			
		Angermouth		Sadmouth	
		M	SD	*M*	SD
Mouth	Pre test	.13	.10	.17	.11
Zone	Post test	.17	.15	.19	.14

Table 4
Proportion of Viewing Time (ms) in Brow Zone at Pre/Post Test

		Smile Types					
		Angerbrow		Sadbrow		Fear	
		M	SD	*M*	SD	*M*	SD
Brow	Pre test	.09	.08	.12	.12	.09	.08
Zone	Post test	.11	.11	.07	.07	.09	.08

Analysis of the results for proportion of viewing time for masking smiles were counter to the expectation of our fourth hypothesis that training participants would show an increase in viewing time in target zones at post test, but control participants would not. Our results revealed no differences between participant groups in viewing times for target zones. There were also no notable changes in viewing times of target zones from pre to post test for masking smiles, with the exception of disgust and sad brow smiles showing a significant *decrease* in viewing times at post test.

Finally, proportion of viewing times in both the eye and mouth zones for happy smiles increased from pre test (eyes, M=.14, SD=.08; mouth, M=.15, SD=.07) to post test (eyes, M=.16, SD=.09; mouth, M=.17, SD=.08). Repeated measures ANOVA of proportion of viewing times for happy smiles, with zones (eye, mouth) and test type (pre, post) as within-subject factors and group (police, student training, control) as a between-subject factor, revealed a main effect of test time [$F(1, 34) = 4.36$, η_p^2=.11]. No effect of zone ($F < 1$) or group was found [$F(2, 36)=1.34$, p=.27]. No significant interactions were found. Although no specific prediction was made in regard to viewing times for target zones in happy smiles that do not contain micro-expressions, these smiles were the only smiles to show a significant increase in viewing time at post test, although once again we see no evidence of our predicted differences between training and control participants.

Relationship of proportion of viewing time to accuracy. We examined the relationship between proportion of viewing time in zones containing micro-expressions and accuracy in recognizing smiles as happy or not happy using a Pearson correlation. It was expected that viewing time in target zones and accuracy in recognizing smiles as happy or not happy would be positively correlated at post test. Table 5 shows correlations of proportion of viewing time for zones and proportion of accurate responses. Significant correlations were found between proportion of viewing time and accurate responses for angermouth smiles [$r(38) = .35$] and fear smiles [$r(38) = -.45$] at post test only, as well as a near significant correlation for disgust smiles [$r(38) = -.32$, $p=.05$] at post test. It is interesting to note that fear smiles and disgust smiles showed a negative correlation between proportion of viewing time and accuracy thus revealing that shorter viewing times in the zones containing the cues for these smiles were associated with higher accuracy rates. Our hypothesis was supported only for the relationship between viewing times in the mouth zone and recognition of angermouth smiles as "not happy". Contrary to our expectations, viewing times in the brow zone for fear smiles were negatively correlated. Also counter to our hypothesis, no other significant correlations between viewing of zones and smiles were found.

Table 5
Correlations for Proportion of Viewing Time in Zones and Accuracy

	Accuracy	
	Pre test	Post test
Zone Viewing Times		
	Correlations	
Anger - brow	-.10	-.17
Sad - brow	.02	-.07
Fear - brow	.26	-.45*
Anger - mouth	.03	.35*
Sad - mouth	-.15	.15
Disgust - nose	-.25	-.32~
Happy - eyes	-.20	.26
Happy - mouth	-.09	-.27

* $p < .05$, ~ $p = .052$

As shown in Table 5, only two smiles types (angermouth and fear) revealed a significant association between increased viewing of target zones and accuracy. It is interesting to note though the trend across smile types toward an increase in association from pre to post test that is best demonstrated by the near significant correlation for disgust smiles. Nonetheless, only angermouth smiles provide support for our fifth hypothesis, while fear smiles show a completely opposite pattern of association from that expected.

Explicit Verbal Identification

Identification of emotions. When participants responded “pretending to be happy” to an expression, they were asked to indicate if the person in the image was feeling another emotion. When participants correctly identified an expression as “pretending to be happy” they also correctly indicated the presence of another emotion 91% of the time. After indicating another emotion as present, participants were asked which other emotion they thought was present in the expression. Our sixth hypothesis predicted that training participants would show increased skill in identifying the emotion being masked by a smile at post test.

Table 6 shows that participant accuracy in identifying the correct emotion increased at post test for disgust smiles and angermouth smiles. To determine participant accuracy in correctly identifying the emotion shown in pretend smiles, a mixed-design ANOVA was conducted with smile type (angerbrow, angermouth, sadbrow, sadmouth, fear, disgust) and test time (pre, post) as within-subject factors, and group (police, student training, student control) as between subject factors. Significant main effects were found for test time [$F(1, 34) = 11.80$, $\eta_p^2=.26$] and smile type [$F(5, 170) = 9.00$, $\eta_p^2=.21$]. There was no main effect of group ($F < 1$). A significant interaction was found between test time and smile type [$F(5, 170) = 2.79$, $\eta_p^2=.08$]. No other significant interactions were found ($F \leq 1.22$). Significant simple effects of smile type were found at post test [$F(5, 360)=10.55$] but not at pre test [$F(5, 360)=1.95$]. Significant simple effects of test time were found for angermouth smiles [$F(1, 216)=13.89$] and disgust smiles [$F(1, 216)=11.39$] but no other smile types ($F \leq 2.04$). Tukey post hoc tests revealed that post test accuracy in identifying angermouth and disgust smiles differed significantly from sadbrow, sadmouth and fear smiles but not from angerbrow smiles.

Table 6
Mean Pre/Post Test Accuracy in Identifying Emotion of Micro-expressions

	Smile Types											
	Angerbrow		Angermth		Disgust		Fear		Sadbrow		Sadmth	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
	Accuracy of identifying emotion											
Pre test	.25	.26	.24	.23	.21	.25	.15	.17	.13	.17	.16	.22
Post test	.28	.27	.42	.27	.38	.21	.15	.19	.20	.23	.16	.20

The outcome of the analyses presented above provides only partial support for our sixth hypothesis. Only identification of the emotion present in angermouth and disgust smiles improved at post test. Ability to identify the emotion was not a function of group membership and therefore not a result of training.

Identification of target zone. For each trial, participants were asked to identify the region of the face that helped them to make their judgment. To correctly identify the region that corresponded to the appropriate micro-expressions, participants must have chosen the eyebrow region for angerbrow smiles, fear smiles and sadbrow smiles. They must also have chosen the mouth region for angermouth smiles and sadmouth smiles, as well as the nose region for disgust smiles. Several participants identified more than one region of the face that they used in making their judgments. Accuracy in identifying the region of the face containing a micro-expression was calculated by taking into account all zones indicated by participants. Therefore, responses were coded as correct if the participant identified the correct zone regardless of how many other zones they indicated. It was predicted that at post test participants in the training group would show an increase in ability to identify the target zone of micro-expressions. This increase in ability to identify target zones was not expected of control participants.

Table 7 shows that participants were more likely to correctly identify the zone when the micro-expression occurred in the mouth region (sadmouth, angermouth). Participants were least likely to correctly identify the zone when it occurred in the nose region (disgust). A mixed design ANOVA with smile type (angerbrow, angermouth, fear, disgust, sadbrow, sadmouth) and test time (pre, post) as within-subject factors and group (police, student training, student control) as a between subject factor revealed a significant main effect of smile type [$F(5, 170) = 10.01$, η_p^2=.23], but no significant main effects of test time or group ($F< 1$) were found. A significant interaction for smile type and test time was also found [$F(5, 170) = 6.00$, η_p^2=.15]. No other significant interactions were found ($F \leq 1.75$). Significant simple effects of smile type were found at post test [$F(5, 360)=15.21$] but not pre test ($F < 1$). Simple effects for test time were found for sadmouth smiles [$F(1, 216)=11.00$], disgust smiles [$F(1, 216)=13.34$] and angerbrow smiles[$F(1, 216)=4.35$]. Tukey post-hoc tests revealed that at post test accuracy in identifying the correct zone for sadmouth smiles differed significantly from all other smile types, and disgust smiles differed significantly from all other smile types except angerbrow smiles.

Table 7
Mean Pre/Post Test Accuracy in Identify Target Zone of Micro-expressions

	Smile Types											
	Angerbrw		Angermth		Disgust		Fear		Sadbrow		Sadmouth	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
	Probability of identifying the target area											
Pre	.47	.33	.45	.36	.41	.36	.40	.33	.44	.33	.49	.37
Post	.32	.32	.54	.31	.15	.23	.46	.29	.42	.26	.73	.30

Our sixth hypothesis was not supported by the finding reported above. There was no significant increase in ability to identify the target zone for masking smiles at post test with the exception of sadmouth smiles. In fact, angerbrow and disgust smiles showed a pattern opposite to our expectations as accuracy in identifying their target zones significantly decreased from pre to post test. As with all of our other analyses, there were no differences between training and control participants in this skill. In the following paragraphs we will discuss the possible reasons that many of our findings were contrary to our initial expectations.

Discussion

The results presented in the previous section address the primary goals of this study. These goals were to examine the effect of micro-expression training (METT; Ekman, 2002) on participant accuracy in detecting and identifying micro-expressions masked by a smile. The roles of experience, confidence and motivation were also assessed in terms of current role requirements (student versus police) and subjective self-ratings. Attentional strategies were examined in order to better understand participants' abilities to detect target cues and use of these cues. Participants' viewing times were recorded with an eye-tracking device thus allowing precise measurement of visual attention. First, results are discussed in terms of accuracy, as well as accuracy as a function of experience, confidence and motivation. Finally, differences between expressions of emotion and use of target cues are discussed.

Accuracy and Experience

An overall lack of group differences in accuracy both pre and post test was found. In effect, law enforcement officers did not outperform students on any measures. The lack of group differences was observed in relation to participants' abilities to identify masking smiles, the emotions masked and the target zones as well as the visual strategies used. These findings are in keeping with previous deception detection research as it is typically reported that there is little difference between law enforcement agents, other deception detection professionals and the layperson or student (Bond & DePaulo, 2006; Garrido, Masip & Herrero, 2004). Bond and DePaulo (2006) report a meta-analysis using 20 comparisons of expert and non-expert detectors that offered no evidence of expert superiority. We provide further evidence that experience in deception detection does not predispose detectors to more accurate judgments.

Despite the absence of differences in detection ability between law enforcement officers and students, our results demonstrate that overall participant ability to distinguish masking smiles as not truly happy, and happy smiles as happy, remained above chance for all smiles with the exception of post test ratings of smiles with anger cues in the mouth. In fact, the accuracy rates achieved here are notably higher than those typically reported in the literature (Ekman & O'Sullivan, 1991; Ekman et al., 1999; Matsumoto & Hwang, 2011; Porter et al., 2000; Porter et al., 2008; Porter et al., 2010). The high rate of accuracy evident in this research is likely a result of the different type of stimuli used in comparison to that typically employed in deception detection research. Deception detection research typically presents participants with video clips of people lying or telling the truth. Our stimuli were static images that were presented for as long as participants needed to form their judgment. This unlimited presentation time allowed participants the advantage of being able to examine the features of facial expressions for as long as they felt necessary to make a judgment, a factor that likely facilitated their ability to do so accurately.

The lack of group differences in general detection skill was further highlighted by a similar lack of difference in performance during the specific perceptual tasks required for successful detection. Namely, the ability to identify the facial regions that contain the relevant cues, as well as to name the emotions displayed by these cues also did not differ across groups. Overall accuracy in identifying the emotion shown by a micro-expression was very low and well below chance level. Accuracy in identifying the target zone of micro-expressions also remained below chance level with the exceptions of smiles with cues for anger and sadness in the mouth region at post test. Despite a high rate of detection and despite their high level of experience, participants have difficulties in locating and identifying the relevant emotions. Ekman (2009) discusses the difficulty observers typically experience in detecting micro-expressions in real time. When shown a real time video clip of a suicidal patient attempting to disguise her sadness and convince her doctors she was feeling good, untrained observers believed that she was in fact happy. Only when the video was played in slow motion were observers able to detect the micro-expression of sadness that flashed across her face and correctly rate her as unhappy. Our results demonstrate that, even in the absence of dynamic time constraints, professionals and laypeople alike have difficulty identifying the emotion being masked by a smile, as well as the target zone of micro-expressions. As demonstrated by the example above, the consequences of not detecting these expressions can be dramatic, particularly in clinical and legal contexts.

Further understanding of the absence of differences between experienced officers and students is offered by the concomitant lack of differences in visual attention strategies used by experienced deception detectors (officers) and students during judgment of masking smiles. This study offers a starting point for future research into the attentional and perceptual processes associated with deception detection. Micro-expressions may occur across a variety of intensity levels; for example, they range from a slight tension in the lips for anger to a full blown expression with brows deeply lowered, and eyelids and lips tightly pressed (Ekman & Friesen, 1969; O'Sullivan & Ekman, 2004). Future research may benefit from using eye tracking to examine the visual processes associated with different micro-expression intensity levels. The use of eye tracking may help us to better understand at what point facial movements become salient to observers, how this point of detection is impacted by experience, and how the interplay of experience and point of detection influence recognition of micro-expression locations and emotions. Future eye-tracking research may also be able to determine if there are differences in the visual search strategies used by detectors with above average success in deception detection. Deception detection research in general would greatly benefit from more use of eye-tracking during detection tasks as this methodology allows objective quantification of visual attention. In follow-up to Bond (2008), eye-tracking studies comparing above average detectors to similar professional with average detection skill may allow us to better understand the visual strategies that set these detectors apart from the majority.

Self-ratings of experience and confidence in deception detection, as well as motivation to learn deception detection skill, did not provide participants with any advantage in either detecting or learning to detect facial cues of deception. The absence of any correlation between pre and post test accuracy and self-ratings of experience, confidence or motivation suggests that successful development of this skill is not linked to experience, need, interest or motivation. This finding further supports previous literature that has reported little to no relationship between these factors and skill in detection (Ekman & O'Sullivan, 1991; Ekman, O'Sullivan & Frank, 1999). Our finding provides an extension of previous research by demonstrating that even when participants rate their own level of motivation to detect deception which allows a clearer picture of motivation level (compared to past research that inferred it based on willingness to participate), motivation continues to have no impact on detection skill or skill development. A comprehensive examination of the demographic, personality and strategic variables that set deception detection "wizards" (80% or above) apart from other detectors would benefit deception detection research. Aside from the thus far undefined talent for detection, personal history and drive may be irrelevant to detection and training success; leaving the burden of success to the training method itself.

Training Effects

It is apparent from our results that the skills acquired during METT (Ekman, 2002) training did not generalize to the masking smile detection task. This lack of generalization was apparent in overall accuracy, as well as accuracy in identifying target zones containing micro-expressions, and identifying the masked emotions presented when pre and post test rates were compared. Warren et al. (2009) also report no association between performance on the METT and deception detection accuracy while viewing videos of liars and truth-tellers. The stimuli used in Warren et al. (2009) were dynamic videos showing the body and face of people lying or telling the truth. These videos were not verified for the presence of deception cues and thus it is possible that trainees' poor performance was a result of an absence of the micro-expression that they were trained to detect. Our deception stimuli, on the other hand, were created and verified to contain micro-expressions in the upper or lower face. Therefore, despite the verified presence of micro-expressions, METT training did not improve participants' abilities to detect or identify them. Another possible explanation of Warren et al. (2009)'s results could be that the videos contained distracting cues not relevant to the task, cues that misdirected participants' attention. For this reason, our participants were presented only with facial expressions known to contain deception cues, and all images were carefully coded to display only expressions of medium intensity. Even in the absence of any possible distracters, METT training did not benefit participants in the detection of micro-expressions masked by a smile. Finally, the dynamic nature of the stimuli used in Warren et al. (2009) allowed the possibility that if micro-expressions were present in deceptive videos, they were nonetheless too brief for newly trained micro-expression detectors to perceive. The stimuli used in the study reported here were static images of expressions that allowed trained participants the advantage of unlimited time to observe the faces they were asked to judge. Despite this advantage in timing, again micro-expression training (METT; Ekman, 2002) provided participants with no advantage in micro-expression detection.

The inability of METT micro-expression training to generalize to a masking smile detection task contrasts with previous reports. These reports link micro-expression detection skill and skill in detecting deception while watching videos of women lying or telling the truth (Ekman & O'Sullivan, 1991). The videos used in Ekman and O'Sullivan (1991) were reported to show an increased presence of masking smiles as the key distinguishing feature during deception (Ekman & Friesen, 1988). In other words, the association between micro-expression and deception detection in Ekman and O'Sullivan (1991) was measured via a detection task in which masking smiles were the key deception cue (Ekman & Friesen, 1988). Despite this reported link between micro-expression detection and deception detection skills using stimuli containing masking smiles, our study was unable to replicate such an association between micro-expression detection on the METT (all trained participants' detection on the METT post test improved dramatically from pre test) and masking smile detection. It is possible that the videos used in Ekman and O'Sullivan (1991) contained indicators of deception other than micro-expressions masked by a smile, such as changes in vocal pitch or lack of contextual embedding (Depaulo et al., 2003; Vrij et al., 2004) and thus these cues confounded the results reported in Ekman and O'Sullivan (1991). It is apparent from the results reported here that METT training and micro-expression detection skill on the METT do not provide any advantage to participants on a detection task that is verified to contain micro-expressions masked by a smile, but which lacks vocal, temporal or body cues.

Improved emotion recognition following micro-expression training with the METT (Russell et al., 2006; 2008) and the MiX (Matsumoto & Hwang, 2011) has been reported. Our results, on the other hand, found no improvement in emotion recognition while viewing masking smiles after METT training. Despite METT training, all trained participants showed no improvement in accuracy when identifying the emotion indicated by micro-expressions; even when they had correctly identified the presence of another emotion. The difference in emotion recognition results reported here may be explained as a result of the difference in stimuli used to test the training systems. Russell et al. (2006; 2008) tested the effectiveness of METT training by presenting participants with images from the facial affect series (Ekman & Friesen, 1976). The facial affect series images are static photographs of full expressions of emotion that contain no masking. Therefore, it is possible that the skills acquired during METT training are limited to identification of complete, unmasked emotional expressions. In this case, it becomes important to question the applicability of METT training for the purpose of deception detection given that masking expressions occur most often during deception, while the type of micro-expressions used for the METT have not yet been reported to occur during deception (Ekman, Friesen & O'Sullivan, 1988; Porter & tenBrinke, 2008). This limitation of the METT system is made apparent here, since METT training using rapid flashes of full emotional expressions did not affect participant performance on our task requiring participants to judge smiling expressions that also contained part of a negative emotional expression.

Matsumoto and Hwang (2011) similarly reported improvement in emotion recognition based on the pre and post test modules within the MiX training. The images in these modules are presented similarly, and contain similar cue formations, to those in the training/review videos and practice module thus requiring little expansion of the learned skill set. For this reason, the results of Matsumoto and Hwang (2011) provide no indication of the generalizability of the acquired skills to other detection tasks. Our findings suggest that these types of micro-expression training systems do not support generalization of the skills learned to other tasks. This limitation presents a serious concern given that the types of deception detection tasks trainees will encounter in real life are likely to involve emotional masking (Ekman & Friesen, 1988; Porter et al., 2008), and to require a need for expansion of detection skill into a more dynamic and complex environment.

Application of micro-expression training to real life deception detection may not be possible. Our findings suggest that the effectiveness of training may be limited to the specific type of presentation and micro-expression viewed during training. Given the current rise of micro-expression detection in the popular media (i.e. television show “Lie to Me”), as well as its recent application to real-life legal and security settings (Ekman, 2009), the use of such micro-expression training systems may instill false confidence in its trainees and risk false positives with dire consequences for the accused.

In order to improve performance in detecting micro-expressions masked by a smile, training may need to focus specifically on the features of masking smiles and the types of micro-expression cues that occur along with them. Given that recent evidence has shown that micro-expressions rarely, if ever, occur across the entire face but appear instead on one region of the face alone (Porter & tenBrinke, 2008; Porter et al., 2012), it would seem prudent for future research to examine deception detection training geared specifically towards identifying these types of micro-expressions. The inability of skills acquired during METT training to generalize to other types of deception detection tasks further supports the assertion of Frank and Feeley (2003) that more research needs to examine the ability of target skills acquired during training to generalize to novel detection tasks. Our main contribution is therefore the discovery that METT training does not generalize to all forms of micro-expression detection. Therefore, training may need to address variations in micro-expressions individually in order to provide a comprehensive and more effective micro-expression training protocol. The following section offers further support for the need to develop training that addresses the unique features of masking smiles, as well as the individual features of masking smiles that contain micro-expressions of different emotions.

Smile Types

Results will be discussed separately for each type of smile. This format became necessary as although we did not expect to find differing patterns of accuracy, identification and viewing times between smiles type, such distinct patterns did emerge as a function of the emotion being masked. The specific emotion masked by a smile was found to influence participant ability to categorize smiles as happy or not happy. Similarly, their ability to identify the emotion being masked and the location of the micro-expression of that emotion varied as a function of the masked emotion. The variation in categorization and identification of target zones and emotions as a function of masked emotion may be one of the most significant outcomes of this study. The emotion recognition literature has consistently reported emotion-linked differences in recognition accuracy for macro-expressions (full emotional facial expressions), such as the nearly infallible identification of expressions of happiness in contrast to a frequently very poor recognition rate for fear expressions (Ekman & Friesen, 1971; Ekman et al., 1987; Gosselin, 2005; Gosselin & Kirouac, 1995; Tracy & Robins, 2008). Our findings offer support, as one of only two reports, for an emotion-based variation for the categorization and identification of emotional expressions that are masked by a smile (Gosselin et al., 2002).

Anger smiles. The first interesting finding was that the categorization of anger masking smiles differed depending on the location of the micro-expression. Within the current study, two different micro-expressions of anger were used: one in the brow area and one in the mouth. When the anger cues were in the brows, smiles were the least accurately labelled as “not truly happy” (pre test = 58%; post test = 50%) compared to the other type of smile containing a micro-expression in the brows. Furthermore, they were significantly *less* well labelled as “not truly happy” at post test than pre test. On the other hand, although anger cues in the mouth are categorized with equal accuracy to most other micro-expressions, they are also one of two masking smiles whose *emotion* was better identified at post test.

Participant attention to the brow zone for smiles with anger in the brows increased from pre to post test, although at both test times participants spent a small proportion of time attending to the brows (pre test = 9%; post test = 11%). While participants were allocating some attention to the target cue, the minimal amount of time spent viewing the micro-expression in the brows, and the low accuracy in categorizing the smile, suggest that participants may be less able to perceive or identify the meaning of the cue in these masking expressions. It is possible that the incongruence between the salient smile and subtle anger cues in the eyebrows creates a conflict for interpretation that forces the observer to disregard the micro-expression and to select the emotion applicable to the most salient cue present– in this case the "happy" smile.

This possibility seemed also supported by the higher accuracy for smiles masking anger when the cue was in the mouth rather than in the eyebrows. Participant ability to categorize angry smiles with cues in the mouth region did not change from pre to post test, and did not differ from any other smile. Participant attention to the mouth also did not change from pre to post test. The positive correlation found between participant attention to the mouth and accuracy for these smiles confirms a performance advantage when attending to anger micro-expressions in the mouth. Participant accuracy in identifying the emotion shown by micro-expressions of anger in the mouth region was also better at post test. In other words, the more time participants spent looking at the mouth, the more likely they were to recognize the smile as hiding another emotion and to correctly identify that emotion as anger. Thus, when the anger cue was in the mouth and therefore influencing the smile, the information available may have been less incongruent and difficult to interpret as the smile itself could not reflect the characteristics of true happiness.

Sensitivity to anger cues in the mouth region of masking smiles has been reported by Gosselin et al., (2002). Adult participants in Gosselin et al. (2002) were shown video clips of two masking smiles with cues for anger of different intensity levels in the mouth, and one smile with the characteristics of a happy smile. Adults were able to correctly distinguish happy from masking smiles, and identify anger as the masked emotion with above chance accuracy. In the present study, a similar pattern of results was evident at post test, suggesting that exposure to angry masking smiles with cues in the mouth assisted participants in distinguishing them from happy smiles and identifying the presence of anger. It may be the case that participants are more sensitive to changes in the mouth associated with anger and therefore attend more to this region when these changes are present. Future research may be able to further elucidate this relationship by comparing participants' eye movement patterns while being asked to distinguish masking smiles with anger cues in the mouth and eyes from happy expressions.

Fear smiles. Interestingly, in contrast to anger smiles with cues in the brows fear smiles that also have a micro-expression in the brows were the best categorized as "happy" or "not truly happy" of all smiles. In fact, they were even more often labelled as not truly happy compared to the happy smile being labelled as truly happy. Participant attention to the target brow region at both pre and post test was low for these smiles (9%).

The negative correlation between attention and accuracy for these smiles suggests that identification of a micro-expression of fear (in the brow) requires little visual attention for a high rate of correct categorization. Therefore, we begin to see a complex pattern of facial expression processing emerge when observers are asked to judge masking smiles. Although for masking smiles with anger cues in the brows observers appear to be misled by the salience of the happy smile, this explanation does not seem to hold when they are judging fear masking smiles. An important query becomes why these differing patterns of categorization exist although the two expressions differ only in the characteristics of the eyebrows. This difference in categorization suggests that judgment of these smiles is not only a matter of cue perception, but also a question of interpretation of these cues.

The high level of accuracy for fear expressions masked by a smile may reflect greater exposure to leakage of fear during masking, as reported by Porter et al. (2012) who found that fear is associated with the highest rate of leakage compared to sadness, disgust and happiness. It is possible that, as reported by Porter et al. (2012), higher real-life exposure to fear masked by a smile predisposes observers to heightened sensitivity to this masked emotion in contrast to other emotions. Future studies may find it beneficial to compare the scan paths (eye movement patterns) associated with judgments of masking smiles with fear and anger cues in the brows. Scan path analyses track the order in which observers fix their attention on the features of an image, thus allowing the detection of visual attention patterns when viewing certain images (Sullivan, Ruffman & Hutton, 2007). As a follow up to our data on time spent attending to a region, examining these patterns of eye movements would provide insight into the dynamic elements of visual attention associated with judgments of these smiles. These dynamic patterns may help to reveal the factors that guide these judgments and lead to divergent recognition rates for these fear and anger masking smiles. Future research would also contribute to the field by inquiring about individuals' knowledge and interpretations of the meaning behind apparent changes in the musculature of the eyebrows.

Despite the highly accurate categorization of these smiles as not truly happy, participant ability to identify the emotion as fear was very low (15%). Previous research in emotion recognition has reported fear as one of the least accurately recognized of the basic emotions (Ekman & Friesen, 1971; Gosselin, 2005; Gosselin & Kirouac, 1995; Gross & Ballif, 1991; Matsumoto & Ekman, 1989; Wiggers, 1982), and our results indicate that this difficulty in fear recognition is equally apparent when fear is masked by a smile. Eye-tracking studies looking at visual search patterns using macro-expressions of fear report the mouth region as providing observers with a recognition advantage over that of the eyes during a visual search task (Calvo & Nummenmaa, 2008). The micro-expressions of fear used here were present only in the eyebrows, which may have further contributed to the recognition difficulties of participants. Identification of the brows as the target zone also did not exceed chance accuracy, a finding that may reflect a previously reported preference for attending to the mouth region when viewing fear expressions, as well as greater difficulty in recognizing fear when the target cue is in the brows (Perron, Roy-Charland & Eady, 2009). Our results provide an interesting extension of previous literature on the recognition of fear, as it is apparent from our results that, although participants show a sensitivity to the presence of fear in masking smiles when categorizing them as truly happy or not, observers remain unable to identify the emotion or the location of the facial cue for that emotion.

Tracy and Robins (2008) examined the evolutionary patterns of emotion recognition by comparing recognition rates during time-limited responses (max. 1000ms) and unconstrained response times (deliberation). Fear was recognized above chance in the first condition in less than 700ms but was still one of the least accurately identified emotions. Deliberation time improved fear recognition that contrasted with disgust, happiness and surprise expressions, none of which were affected by time to deliberate. In light of previous studies finding that emotion recognition for negative emotions such as fear is slower than for positive emotions such as happiness, while the opposite pattern is true when these stimuli merely have to be detected (Hugenberg, 2005; Leppänen, Tenhunen, & Hietanen, 2003; Ohman, Lundqvist, & Esteves, 2001), Tracy and Robins (2008) suggest that perceptual sensitivity to fear may facilitate rapid detection while interfering with its categorization as “fear” given its urgent message (i.e., danger). Future studies may want to further explore this contrast of high detection and low recognition for fear expressions masked by a smile by combining Tracy and Robins (2008) recognition tasks with the use of eye movement recording.

Sad and disgust smiles. Expressions of sadness and disgust masked by smiles showed an intermediate pattern of results compared with that of other expressions; therefore, they will be discussed here together. Sad smiles with cues in the brow and mouth were no more or less accurately categorized than other smiles. Participants attended more to the target brow region for smiles with sadness cues in the brow at pre test. This trend was reversed for sad smiles with cues in the mouth, as participants attended more to the mouth region at post test. Participants also more accurately identified the target zone as the mouth at post test for sad smiles with cues in this zone. This did not occur for smiles with cues in the brows. These findings suggest that participants may be more sensitive to the presence of micro-expressions of sadness in the mouth region, facilitating their ability to identify the target zone.

In visual search paradigms where participants have to identify the presence of an emotional expression amongst neutral expressions (Calvo & Nummenmaa, 2008) and in eye tracking studies in which participants perform a macro-expression recognition task (Eisenbarth & Alpers, 2011), results typically show an advantage of the eye region over the mouth when sad expressions are not masked. Our results contrast with these studies. This difference in performance between cue regions may be due to a variety of factors. First, it may reflect greater exposure to masking smiles with cues to sadness in the mouth region, as Porter and ten Brinke (2008) report that micro-expressions of sadness occur more often in the lower face than in the upper face during masking.

Second, similarly to anger brow masking smiles, the contradiction between a happy smile and sad eyes may make interpretation so difficult for observers that they prefer to use the salient smile as the primary cue. Finally, as with masking smiles with anger cues in the mouth, it is plausible that sad smiles with a micro-expression in the mouth region facilitate identification of the mouth as the target zone due to distortion of the salient and familiar happy smile. Future eye tracking studies may be able to determine differences in the allocation of visual attention between macro-expressions of sadness, and micro-expressions of sadness masked by a smile.

Participant categorization of disgust smiles also did not differ from other smile types or from pre to post test. On the other hand, participant ability to identify disgust as the emotion presented increased from pre to post test, while identification of the target zone decreased. Participants also attended less to the target nose region at post test. It is apparent that although practice did not provide participants with an advantage in categorizing these smiles as not happy, when participants correctly did so they were better able to identify disgust as the emotion presented. Practice did not contribute to recognition of the target region either implicitly (visual attention) or explicitly (verbal identification). Interestingly, our results demonstrated that participant inability to accurately identify the target zone and decreased attention to the zone did not negatively affect their identification of disgust as the emotion presented. This pattern of results may suggest that observers do not need to allocate much attention to the micro-expression in the nose to recognize disgust. Tracy and Robins (2008) report high recognition rates for disgust under rapid detection, deliberation and cognitive load conditions suggesting that disgust expressions are easily detected and recognized across conditions. Future research comparing the recognition of disgust expressions with and without the characteristic changes in the nose region may provide more insight into the importance of the nose to the recognition of disgust.

Our results for masking smiles with cues to sadness and disgust show unique patterns of attention and recognition. Masking smiles with sadness in the brows are not distinctly recognized overall, although studies using macro-expressions of sadness tend to report an advantage for attention to the eyes. On the other hand, sad smiles with cues in the mouth region had the most well identified micro-expression zone at post test that differed from its poor identification at pre test. Despite this improvement in zone identification, accuracy for categorization of these smiles as not truly happy, or identification of sadness as the emotion, was not notable. Finally, disgust proved to be one of the most well recognized of the masked emotions, although categorization as not happy and zone identification were not. These very distinct patterns of results across emotional expressions imply that the visual and perceptual processing of these masking smiles differs dramatically based on the location and emotion associated with a micro-expression.

Happy smiles. The most interesting finding of the current study was the impact of practice on categorization of, and attention to, happy smiles as “truly happy”. Happy smiles are characterized by lifting of the corners of the lips upward, lifting of the cheeks and creasing at the outer corners of the eyes. Happy smiles are consistently distinguished by adults with above chance accuracy from posed smiles, which lack the cheek raiser movement that causes crow’s feet and bulging of the eyelids during smiling (Gosselin et al., 2002; Miles & Johnston 2007). This detection ability is also apparent when observers are asked to distinguish happy smiles from masking smiles of anger (Gosselin, et al., 2002).

In the present study, happy smiles began as one of the two least accurately categorized (truly happy) smiles at pre test, and then became one of the two *most* accurately categorized at post test. They were also the only smile type to show an increase in accuracy from pre to post test. Participants' attention to the target eye and mouth regions for happy smiles increased from pre to post test along with accuracy. Following practice, all participant attention to happiness cues, and identification of these cues as an indication of being "truly happy" improves despite the fact that their skill in detecting masking smiles containing cues to deception does not. As suggested by Calvo and Nummenmaa (2008), perhaps the familiarity of the characteristics of a happy smile predispose observers to more easily learn and detect these features in contrast to those of masking expressions. Quite contrary to our expectations, despite any performance benefit of micro-expression training or practice effect for masking smile detection, practice allowed participants to gain a significant advantage in categorizing happy smiles as happy. Our results indicate that not only are happy smiles the most salient, easily perceived and recognized emotional expressions of all (Calvo & Nummenmaa, 2008; Ekman & Friesen, 1971; Ekman et al., 1987; Tracy & Robins, 2008), but they also allow for rapid, unassisted learning of the cues that distinguish expressions of true happiness from other expressions. This effect suggests that research and practice may benefit more from a focus on detection of *truthfulness* rather than the typical emphasis on detecting deception, as demonstrated by the ease with which skill in detection of expressions of authentic happiness appears to be acquired.

Sensitivity to expressions of happiness is thought to facilitate successful social interactions with others (Ekman, 2003; Fredrickson, 1998; Hess, Banse & Kappas, 1995; Keltner & Haidt, 1999; Shiota, Campos, Keltner, & Hertenstein, 2004) by allowing perceivers to modify responses in an appropriate manner for the maximization of cooperative interaction (Ekman, 1999). Expressions of happiness have been found to be one of the most easily recognized expressions of emotion (Ekman et al., 1987; Surakka & Hietanen, 1998; Tracy & Robins, 2008). Compared to other emotional expressions happy smiles have been shown to be more rapidly recognized (Kirita & Endo, 1995), even when presented extra-foveally (Calvo, Nummenma, & Avero, 2010). They have also been found to provide a search advantage compared to other emotional expressions when scanning a crowd (Juth, Lundqvist, Karlsson & Öhman, 2005) and to elicit greater amygdala activation [the amygdala is a key region for processing the social relevance of information from the face (Costafreda, Brammer, David,& Fu, 2008)] during rapid presentation that allows only non-conscious processing (Juruena et al., 2010).

Similarly, true enjoyment smiles compared to polite smiles have been found to influence ratings of others as more positive and sociable (Frank, Ekman & Friesen, 2005; Mehu et al., 2007); to alter the facial and emotional reactions of observers (Surakka & Hietanen, 1998); to provide preferred behavioural reinforcement over non-social incentives (e.g., money) (Shore & Heerey, 2011); and to be more easily recognized by people experiencing social exclusion (Bernstein, Young, Brown, Sacco, & Claypool, 2008). These findings taken together suggest that rapid detection of happy expressions serves an important ecological function. The recognition advantage of happy faces may provide this ecological benefit by facilitating detection and recognition of “friends” versus “enemies”, thus facilitating mutually beneficial social interactions via the elicitation of pro-social feelings and behaviours from detectors. The reciprocal nature of social interactions based on the presence of happy versus pretend smiles offers ample fuel for further research in the years to come.

In Summary

Our research has shown that micro-expression training that utilizes full emotional expressions does not generalize to the detection of masking smiles that contain micro-expressions in one region of the face regardless of the level of experience, confidence or motivation of the trainee. Visual attention to and identification of emotions and zones varies as a function of the emotion. Most notably, practice facilitates a significant improvement in observer skill at recognizing truly happy smiles despite its lack of impact on masking smile detection. Learning to detect negative micro-expressions in a smile may require specialized training in the combination of cues that observers encounter when faced with such deceptive expressions, such as the presence of micro-expressions in only the upper or lower part of the face and the effect of the combined action of smiling (i.e., lip corner puller) and leaked micro-expressions (e.g., lip tightener).

Development of a comprehensive and effective deception detection training system requires greater collaboration of research within the field. As Frank and Feeley (2003) demonstrated in their examination of the limitations and challenges facing deception training research, training tools require more rigorous assessments which should include verifying the presence of deception cues in stimuli, real-life relevance to of tasks, testing generalizability on novel tasks and testing long term retention of learned skills. The verification of the presence of deception cues in stimuli can be achieved by careful coding of facial expressions and body language in deception stimuli prior to inclusion in training paradigms. Real-life task relevance will differ depending on the real-life deception scenarios faced by trainees. For example, a homicide investigator would require deception detection skills in an interrogation-type scenario whereas a psychologist would require these skills in a counseling situation. The environmental, emotional and psychological factors involved in these scenarios may differ significantly and thus alter the expression of deception cues. In order to maximize training effectiveness, these differences must be accounted for when designing stimuli and training paradigms. Finally, testing the generalizability and long term retention of these skills requires post-training testing on a novel but related task, and testing several days or weeks later to ensure the retention, and thus viability of the training for real-world application. The research presented here has attempted to begin to address many of these challenges, and research in the future will benefit the broader field of deception detection by taking our findings into consideration and building upon them.

Limitations

Some limitations of the present study exist that future research may have the opportunity to address. These limitations include use of a task with little similarity to the complexity of real world authenticity judgments. This paradigm was chosen in order to allow greater control of confounding cues and thus provide clearer insight into the processes of attention and interpretation associated with these judgments. From here, future research may be able to build upon our findings by integrating more realistic deceptive stimuli into eye tracking studies of deception detection. Similarly, our paradigm presents a limitation as a result of the use of the same set of images at both pre and post test. This format limits our ability to determine whether the practice effects observed were a result of skill development or mere familiarity with the images presented. Future research may be better able to make this determination by presenting participants with a novel set of images at post test. Another limitation of this study was the long length of the testing and training sessions (2-3 hours) that may have affected participant ability to remain focused throughout testing. This presents a notable concern in interpretation of our results as post test data may have been confounded by loss of attention. Future research may be able to address this potential confound with a modified pre and post test format that requires less time to complete. Nonetheless, the preliminary findings of this research on deception detection training and judgment of masking smiles has provided a useful foundation from which our knowledge of masking smile detection may grow.

Future Research and Implications

Future studies should focus on the two most prominent findings presented here. First, the complete lack of a training effect leaves much to be explored in terms of training in masking smile detection. As detection of masking smiles has been until now an unexplored area of deception detection training, in future days researchers will have many new questions to tackle. Despite the lack of prior research in this area, our findings suggest that familiarity may play a large role in the detection of several emotions including fear masked by a smile and truly happy smiles. For this reason, future training may want to examine the minimum limits of practice exposure required for participants to become excellent detectors for each emotion masked by a smile. Our results suggest that minimum practice exposure required will differ depending on the emotion being masked. Future studies may also offer participants training in deception cues relevant to only a subset of masking smiles at one time, as compared to a complete set of masking smile cues, to determine whether participants are better able to retain and utilize this information when it is presented in smaller chunks. Once a masking smile detection training system has been proven effective in improving participants' detection skills on novel detection tasks, it may again become pertinent to begin to look at possible differences between high and average motivation groups. At this point it is plausible that our lack of group effects was merely a result of an overall lack of training effect.

The second prominent finding of this study that requires further research is the relatively rapid improvement of happy smile detection via exposure alone. It is interesting that the only improvement in detection reported here was for the smiles showing true enjoyment rather than masking smiles. In follow-up to this study, it is also important to determine if the improved detection of happy smiles will hold constant when post test stimuli are novel rather than repeated. Given the consequences of incorrectly identifying a witness or suspect as lying, further exploration of the mechanisms that facilitate the process of identifying a truthful suspect is needed. One of the hazards of physiological measures of deception is the possibility of false alarms in that an innocent suspect is considered to be guilty (anxiety may activate the physiological system being measured). Our findings suggest that detection of sincere expression may be easier to train and allow greater improvements in accuracy, although further research is required to determine the reliability of this effect.

The implications of this research are vast as deception detection plays an important role in many professional as well as personal interactions. For example, in the pursuit of maintaining the security and social order of any city police must constantly determine the truthfulness of statements made to them. Similarly, parents are often faced with the task of assessing the veracity of their children's statements in order to guide their children away from harmful temptations such as drugs and alcohol. An effective training system that prepares trainees for the kind of masking smile deception they will often encounter in real world deception is crucial. Therefore, beginning with the results presented here, researchers may begin to put together a more comprehensive and effective deception detection system that includes emphasis on the masking of emotions.

In keeping with the suggestions of Frank and Feeley (2003), our results emphasize the importance of using pre and post test designs to properly assess the contribution of training. Similarly, our results also offer support for the assertion that in order to determine the applicability of a training system to real life deception detection, it is critical to establish that the trained skills will generalize to other related tasks. In order to properly develop an effective training for masking smile detection, we must first develop a better understanding of how observers perceive and interpret masking expressions. Tools such as eye tracking will be crucial to understanding these processes. With a better understanding of masking smile perception we may begin to build a training system that maximizes these processes and compensates for related perceptual weaknesses. Part of the development process toward a reliable training system must include close examination of each masked emotion individually, as our research has shown that masked emotions are perceived and processed as differently as those unmasked. With this knowledge, a training system may be developed and rigorously tested following the guidelines of Frank and Feeley (2003). A training system with such a strong empirical foundation could have profound implications for professionals including doctors and nurses, lawyers and judges, police and parole officers, as well as youth and mental health workers. In fact, any person whose task it is to make decisions that will affect the welfare of another, based on their judgment of that person's authenticity, is in need of a reliable tool to assist them in this consequential process.

In conclusion, the results of this preliminary investigation into the training of micro-expression detection as applied to masking smile detection suggests that deception detection research and application may need to begin moving in new directions. Our findings demonstrate that real-life micro-expression detection may be a task that is beyond the scope of most people's abilities even with training, and thus a waste of resources to pursue further. As proposed by ten Brinke and Porter (2011), the occurrence of micro-expressions is so rare that they may be limited in terms of their usefulness as cues to deception. Instead, our findings suggest that detection of sincerity may provide a more fruitful area for further pursuit in research and possibly later in practice. The implications of false positives or false negatives in deception detection in legal and clinical contexts is significant in that there is the potential to overlook the suicidal patient, imprison the innocent suspect, or release a homicidal criminal. Misapplication of detection training systems that are not effective in a novel context, let alone a complex real-world scenario may have serious consequences. For this reason, it is imperative that research continues to verify or debunk deception detection cues and training tools prior to their application in practice. The futures of the professionals who use these tools and the people they use them to assess depend on it.

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Appendix A

Participant Questionnaire

Questionnaire – Part 1

In order to determine the influence of personal qualities on ability to detect deception, we would like to ask you to complete the following questionnaire. All information collected here, will be kept completely confidential and will be used anonymously. You may skip any questions that you do not feel comfortable answering, and are free to withdraw from the study at any time.

1. Please circle your age category from the choices below:
    a. 18-25
    b. 26-30
    c. 31-35
    d. 36-40
    e. 41-45
    f. 46-50
    g. 51-55
    h. 56+

2. Please circle your gender from the choices below:
    a. Male
    b. Female

3. My future career goal is (If you are uncertain, please write "unknown" or all career options that you are considering): ____________________
____
____
____
____
____
____
____
____
____
____
____

Please select your answer to the following questions on a scale of 0 to 9, with 0 being "Strongly Disagree" and 9 being "Strongly Agree".

4. Before taking part in this study, I was interested in learning to read facial expressions.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

5. Before taking part in this study, I was interested in learning to detect deception.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

6. Before taking part in this study, I was good at reading other people's facial expressions.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

7. Before taking part in this study, I was good at recognizing when other people are lying.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

8. Being able to judge when others are being truthful is relevant to my future career goals.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

9. Being able to judge when others are being truthful is relevant to me personally.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

<u>Questionnaire – Part 2</u>

We are interested in the effects of experience and job relevance on ability to judge facial expressions. For this purpose, we ask that you complete the following questionnaire regarding your work experience. All information collected here, will be kept completely confidential and will be used anonymously. You may skip any questions that you do not feel comfortable answering, and are free to withdraw from the study at any time.

10. Please write your job title below:

____

11. Please circle your years of experience in your field:
    a. 0-2 years
    b. 3-5 years
    c. 6-10 years
    d. 11-15 years
    e. 16-20 years
    f. 21-30 years
    g. 31-40 years
    h. 41+ years

12. Please circle your years of experience in your current job role:
    a. 0-2 years
    b. 3-5 years
    c. 6-10 years
    d. 11-15 years
    e. 16-20 years
    f. 21-30 years
    g. 31-40 years

h. 41+ years

Please select your answer to the following questions on a scale of 0 to 9, with 0 being "Strongly Disagree" and 9 being "Strongly Agree".

13. I frequently need to judge the sincerity of other people in my work.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

14. The outcome of the judgments I make regarding the sincerity of others has important consequences for myself and/or others.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

15. Learning to judge the sincerity of facial expressions will help me do my job better.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

16. Learning to judge the sincerity of facial expressions may help me achieve my career goals.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

Appendix B

Examples of Smile Stimuli

Happy Smile

Fear Smile

SadBrow Smile

AngerBrow Smile

Disgust Smile

AngerMouth Smile

SadMouth Smile

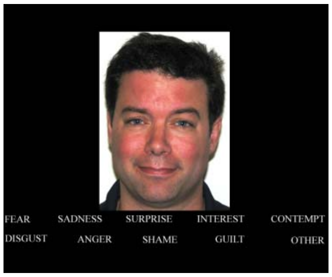
Appendix C

Masking Smile Pre and Post Test

1) Is this person truly happy or pretending to be happy?

2) Do you think this person is feeling any other emotion?

3) What emotion do you think they are feeling?



4) What part of their face makes you think they are feeling that?