DARWIN THE DETECTIVE:
BEHAVIOURAL CONSEQUENCES OF HIGH-STAKES EMOTIONAL DECEPTION

by

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B.Sc. (Hons.), Dalhousie University, 2007

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

The College of Graduate Studies

(Psychology)

THE UNIVERSITY OF BRITISH COLUMBIA

(Okanagan)

April 2012

Abstract

Deception evolved as a fundamental aspect of human social interaction. Although numerous studies have examined behavioural cues to deception, most have involved inconsequential lies and unmotivated liars in a laboratory context. With a novel paradigm, the present dissertation is the most comprehensive study to date of the behavioural consequences of extremely high-stakes, real-life deception relative to comparable real-life sincere displays using three communication channels: speech, body language, and emotional facial expressions. Televised footage of a large international sample of individuals ($N = 78$) emotionally pleading to the public for the return of a missing relative was meticulously coded frame by frame (30 frames per second, for a total of 98,393 coded frames). About half of the pleaders eventually were convicted of killing the missing person based on overwhelming evidence. Failed attempts to simulate sadness and leakage of happiness revealed deceptive pleaders' covert emotions, as hypothesized based on observations by Charles Darwin and a contemporary understanding of human facial innervation. Specifically, full contraction of the *frontalis* (failed attempts to appear sad) muscles and subtle contraction of the *zygomatic major* (masking smiles) were more commonly identified in the faces of deceptive pleaders. In contrast, prototypical aspects of "grief," as produced by the *corrugator supercilli*, and *depressor anguli oris* muscles were more often contracted in the faces of genuine than deceptive pleaders. In addition, liars used fewer words, but more tentative words than truth-tellers, likely relating to increased cognitive load and psychological distancing. Further, simultaneous attention to each of these cues – tapping emotional arousal, cognitive load, and psychological distancing theories of deceptive behaviour – discriminated 90% of pleaders correctly, supporting the multiple cue approach to deception detection. Findings further reveal the secrets of the human face and contribute to our understanding of human communication more generally.

Preface

Chapter 2 is based on work conducted in collaboration with my doctoral supervisor, Dr. Stephen Porter, beginning at Dalhousie University and completed at University of British Columbia. I was responsible for the collection of cases, coordination of blind coding, derivation of hypotheses, data analysis, and manuscript preparation. This work has been accepted for publication in *Law and Human Behavior* and permission has been granted by Dr. Brian Cutler (Editor, *Law and Human Behavior*) for presentation of this manuscript in the present dissertation.

Research presented in Chapter 3 is currently in press in *Evolution and Human Behavior* and is reproduced here with permission. This research was conducted at University of British Columbia, under the direction of Dr. Stephen Porter. Co-author Alysha Baker was responsible for blind coding and assistance with manuscript preparation. I derived hypotheses, conducted data analysis, and led manuscript preparation.

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Acknowledgements

Words cannot express my gratitude and admiration for my supervisor, Dr. Stephen Porter. You have been a constant source of intellectual encouragement, motivation, and support. More than that, I count you among my closest friends and greatest influences upon my life. Thank you. For everything.

I also offer enduring gratitude to my committee members, Drs. Michael Woodworth and Jan Cioe. Your constant encouragement and thoughtful consideration of my work has allowed me to produce a dissertation that I can be proud of. Further, I owe tremendous thanks to countless faculty, staff and students at Dalhousie University and University of British Columbia who have assisted and inspired me over the past five years. Tara Carpenter, Sabrina Demetrioff, Marcus Juodis, Jorno Hermans, Dr. Paul Davies, and Jan Paseska deserve more than a special mention. To my family (Greg, Melissa, and Michelle) and friends who have shared in the highs and lows of my graduate school experience, you have contributed more to this work than you realize. Igal Rogalsky and Victor Narynskyyi must be recognized further – I could not ask for more supportive men on my side.

I also would like to extend my sincere appreciation to Alysha Baker, Sarah MacDonald, Joyce Yu, Lacey Peters, and Dr. Brian O'Connor for their contributions to this research. Your assistance was integral to the completion of this project. Lastly, I thank the Social Sciences and Humanities Research Council of Canada (SSHRC) and the Natural Sciences and Engineering Council of Canada (NSERC) for their financial support throughout my graduate studies.

Dedication

To my parents.

To my father, for instilling in me your insatiable curiousity and love of learning. I count our days spent watching The Nature of Things, flipping through your stacks of National Geographic, and listening to Quirks and Quarks as significant influences in my scientific development. For encouraging me to ask "Why?" and seek the answer; I am forever indebted to you for this and countless other reasons. Your thoughtful approach to life's challenges has become a part of my scientific method.

To my mother for her never-ending encouragement, love of accomplishment, and unrelenting productivity. Adopting your hard-working attitude and perseverance has allowed me to achieve more than I have ever thought possible. You have been the first person I call to share my successes and failures. Thanks for always being there to offer your unwavering support.

Together, you have provided me with the tools I needed to complete this journey and I love you for standing beside me each step of the way.

1. Chapter One. Introduction

Deception has evolved to become a fundamental aspect of human interaction (O'Sullivan, 2003; Trivers, 2011). A form of exploitative resource acquisition, lies are a common occurrence and represent a communicative strategy also employed by other species to assist in procuring resources necessary for survival and reproduction (e.g., Buss & Duntley, 2008). Like the broken-wing dance employed by a mother bird to distract a predator from her vulnerable young, many day-to-day lies told by humans are meant to protect others (Premack, 2007). On average, we lie twice daily and most often tell "white lies" to spare the feelings of our counterparts (DePaulo, Kashy, Kirkendol, Wyer, & Epstein, 1996). For example, the astute husband quickly learns that there is only one appropriate answer to the question, "Does this dress make me look fat?" despite the reality of his wife's appearance. However, lies may also be self-serving and potentially consequential. Like the non-dominant male Sunfish (*Lepomis*) who uses his feminine appearance to hijack mating rituals between a dominant male and female, some human lies are selfish and promote reproduction (Desjardins & Fernald, 2009). The unfaithful husband explains to his wife that he needs to work late while he spends his evening with a young mistress. Indeed, romantic partners are overwhelmingly reported as the victims of our most consequential lies (DePaulo, Ansfield, Kirkendol, & Boden, 2004; Whitty, Buchanan, Joinson, & Meredith, 2011). However, lies of even greater consequence are sometimes told – lies that threaten the safety and security of society.

> *I got the impression that here was a man who could be relied upon when he had given his word.* (Ekman, 1992, pp. 15-16)

These were the infamous words of British Prime Minister Neville Chamberlain, describing Adolph Hitler's behaviour as Hitler swore that he would not invade Czechoslovakia –

a failed credibility assessment that led the world to war. On September 11, 2001, terrorists strolled through airport security, concealing their intentions as they executed their murderous mission. More commonly, detectives are faced with perpetrators who vehemently deny involvement in criminal activity in an attempt to avoid punishment for their actions. The American public was gripped by the disappearance of pregnant Laci Peterson and rallied around her husband, Scott, in hope of her safe return. However, the public had been deceived; Scott Peterson eventually was sentenced to death for the murder of his wife. More recently, Canadian wife-killer, Michael White, made a televised appeal for the safe return of his wife Liana. His emotional appeal even garnered the support of Liana's mother; however, White was subsequently found to be in possession of Liana's bloody clothes and was seen on surveillance video running away from the scene of the crime. He was convicted of her murder on December 7, 2006 (CTV News, 2006).

1.1 Deception Detection

How could Chamberlain have made such a cataclysmic error in reading Hitler's duplicity? And why are we continually duped by emotional pleaders playing the part of the distressed relative? Although humans have evolved to deceive, it does not appear that we are similarly gifted with the natural ability to detect deception, seemingly counter to Trivers' (2006) assumption that the co-evolutionary arms race between the deceiver and the deceived would promote the selection of this skill. When faced with a deception detection task, humans rarely outperform chance (Bond & DePaulo, 2006), despite high levels of confidence in deception detection ability (Porter, Woodworth, & Birt, 2000). In a seminal study of various professional groups' (e.g., psychiatrists, police, judges) ability to detect deception, only U.S. Secret Service officers performed above chance, achieving a meager 64% accuracy rate (Ekman & O'Sullivan,

1991). When a group of police officers were shown video footage of emotional pleas to the public by deceptive murderers not unlike Michael White, approximately half were thought to be genuinely distressed, innocent relatives. Police officers could not detect deception in this context beyond what would be expected from the flip of a coin; accuracy was unrelated to age, years on the job, or rank (Vrij & Mann, 2001a). Poor deception detection ability has been attributed to a reliance on invalid cues to deception (e.g., gaze aversion), innate human biases (e.g., what is beautiful is good, and honest), and over-confidence, leading to tunnel-vision decision-making (Porter & ten Brinke, 2009). However, recent meta-analytic research by Hartwig and Bond (2011) suggests that lie detectors in fact do attend to valid behaviours, perhaps outside of their own conscious awareness since they often self-report invalid cues (e.g., gaze aversion). As such, Hartwig and Bond (2011) suggest that lie detectors more likely fail due to the subtlety or absence of behavioural cues 'leaked' by the deceiver, particularly during low-stakes lies (DePaulo, Kirkendol, Tang, & O'Brien, 1988; O'Sullivan, Frank, Hurley, & Tiwana, 2009).

1.2 Historical Deception Detection Methods

Although self-reported cues to deception often lack empirical support, investigators have long been interested in behavioural manifestations of deception. As early as 900 BC, specific instructions for the interpretation of deceptive behaviour were written: "He does not answer questions, or they are evasive answers; he speaks nonsense, rubs the great toe along the ground, and shivers; his face is discoloured; he rubs the roots of the hair with his fingers; and he tried by every means to leave the house …" (quoted in Trovillo, 1939, p. 849). Six hundred years later, the Greek physician, Erasistratus, posited that pulse could be monitored to reveal deceit. Further, and as recorded by Greek historian, Plutarch, it was by measurements of pulse that the source of Antichus's illness was revealed. His pulse quickened as his step-mother, Stratonice, entered the

room revealing the all-consuming love he had developed for her, and hid from his father, Seleucus I of Syria.

Promising behavioural analyses fell to practices of trials by ordeal or torture, based on superstition and religious faith between the time of Christ and the Middle Ages. Those who administered the trials did not believe that proof of innocence or guilt lay within or upon the suspect himself, rather that divine forces would intervene during the ordeal and reveal signs of deceit or truthfulness. For example, a suspect may prove his or her innocence by applying a red-hot iron to the tongue nine times, or until burns were caused. If burnt, the suspect was presumed to be lying and was subsequently put to death. Alternatively, the ordeal of rice chewing, borrowed from investigators in India and used during the Spanish Inquisition, had suspects chew rice (or bread, if rice was not available) and attempt to swallow the food. If the suspects were guilty, they would be unable to swallow even the smallest morsel of food. While the inability to swallow might be attributed to decreased salivary action related to nervousness or guilt about lying, an alternative faith-based hypothesis for the behaviour was favoured. It was believed that God would send the angel Gabriel to stop the action of the liar's throat, making him or her unable to swallow, exposing the deceitful suspect (Trovillo, 1939).

1.3 Theories of Deceptive Behaviour

Contemporary researchers expect that the behavioural presentation of liars and truth-tellers will differ because of the elevated arousal, cognitive load, and/or required behavioural control associated with lying (Porter & ten Brinke, 2010; Vrij, 2008a; Vrij, Granhag, & Porter, 2011). The liar may be forced to avoid betraying the deception by controlling feelings of guilt or excitement while monitoring his/her words to maintain the consistency of deceptive details. While providing enough detail to appear credible, the liar is likely to avoid providing excessive

details, which may lead to problems recalling and maintaining the falsified information. While relaying the falsehood to a potentially skeptical audience, the liar may also need to control facial expressions (sometimes having to conceal or falsify an emotion) and monitor body language. Achieving this task may be made easier by psychologically distancing him- or her-self from the lie by modifying language (e.g., using fewer pronouns) to avoid responsibility for the lie or the abhorrent deed he/she is denying. However, this strategy leaves footprints upon the liar's narrative that may be discernable to the informed observer. The necessary "multi-tasking" required to successfully deceive reduces the level of conscious control over each behavioural channel, and increases the likelihood of relative "leakage" from the other(s), depending on which he/she is devoting relative degrees of effort. In general, because liars are expected to be more emotionally aroused, more likely to attempt to control their behaviour, distance themselves from their actions to avoid responsibility, and are presumed to be engaging in a more cognitively demanding task than truth tellers, opportunities arise for the unintentional communication of the deception.

1.4 Behavioural Consequences of Emotional Arousal

It is expected that liars are more likely to experience guilt, fear, and/or duping delight, relative to truth-tellers, and that this emotional response will manifest in emotional facial, body language, and speech behaviours that reveal deception (Vrij, 2008a). This affective response has been measured generally, as arousal, via physiological channels such as heart rate and skin conductance. Similar to the supposition of Erasistratus, the measurement of heart rate first was proposed as an indicator of fear, and potentially of that related to deception, by Italian psychiatrist Césare Lombroso in the late nineteenth century. Lombroso several times assisted the police in identifying deceptive criminal suspects by monitoring both heart rate and blood

pressure during interrogations, a method he described in his *L'Homme Criminel* (1895). By 1908, Hugo Munsterburg was advocating the use of these methods for the detection of deception in the courts to a resistant and skeptical audience (Wigmore, 1909). These methods – precursors of the modern polygraph – remain a topic of contention today. Despite its popularity in police settings, the polygraph is criticized for its high false positive rate, subjective scoring methods, and susceptibility to countermeasures (Ben-Shakhar, 2001; Honts, Devitt, Winbush, & Kircher, 1996; Porter & ten Brinke, 2010; Vrij, 2008a). Measures of generalized physiological arousal, such as those measured by the polygraph (i.e., blood pressure, skin conductance) may be complemented by attention to facial expression, which provides indicators of both emotional arousal and valence.

1.4.1 Facial expression of emotion.

The functional benefits of emotional facial expressions were a major focus of Darwin's (1872) *Expression of Emotion in Man and Animals*. For example, he speculated that the narrowed eyes of anger focused attention upon the object of rage and barred teeth readied the bearer for attack. Recent research examining the functionality of emotional expression empirically supports Darwin's contention, finding predictable sensory acquisition benefits inherent to expressions of fear, surprise, anger, and disgust (Susskind & Anderson, 2008). Further, these expressions do not benefit the bearer alone; such behavioural manifestations of affective states also have been co-opted by observers as an informative aspect of human communication (Schmidt & Cohn, 2001).

Facial expressions convey such vital information about feelings and intentions that we quickly "read" the faces of strangers we encounter to make global and specific inferences about both their state (emotions and intentions) and trait characteristics (Martelli, Majib, & Pelli,

2005). The accurate interpretation of emotional expression can promote both survival and reproduction. Faces appear more attractive when the individual is smiling and engaging in direct eye contact with the observer, potentially signaling a mating opportunity (Jones, DeBruine, Little, Conway, & Feinberg, 2006). And we quickly recognize if someone is enraged when he/she approaches exhibiting the contraction of certain facial muscles such as the *corrugator supercilli* and *procerus* (to lower the brows and produce horizontal wrinkles on the nose), *levator labii superioris* (to flare the nostrils), the *orbicularis oculi* (to produce flashing eyes), and the *orbicularis oris* (to clench the jaw). Rapidly recognizing such a facial expression, one might wisely choose to avoid the angry individual and seek more agreeable company (e.g., Williams & Mattingley, 2006). Often, however, facial expressions are more difficult to interpret than a salient display of anger.

Interpretation may be made difficult for the observer for a variety of reasons. For example, facial expressions may be subtle, in accordance with a less powerful affective state. Further, people frequently attempt to stifle an emotion (neutralization), present an emotion opposite to the one truly felt (masking), or present a false emotion even though their affective state is neutral (simulation). Each of these types of deception is accomplished by changing or inhibiting a facial expression normally accompanying an emotional state (e.g., Ekman, 1992, 2003; Ekman & Friesen, 1969). Clearly, given the poor accuracy rates of deception detectors described earlier, such attempts to feign or inhibit emotional expressions often are successful; however, a rich history of theory and research on human emotional expressions suggests that the face may reveal covertly held information to the trained and attentive observer.

1.4.2 Historical and theoretical foundations for facial expressions as a cue to deceit.

The basic contention that it is difficult to falsify certain facial expressions has its origin in the work of Guillaume Duchenne, a French physiologist who – using technological advances in photography – began to document the facial action associated with genuine and false smiles in the 1800s (Duchenne, 1862). Duchenne noted that the common conceptualization of an expression of happiness is the contraction of the *zygomatic major* muscle, which upturns the corners of the mouth into a smile. However, when he electrically stimulated the *zygomatic major* muscle to create this action, the resulting expression did not seem "genuine." Genuine expressions of happiness, he reasoned, also involve the activation of the *orbicularis oculi*, the muscle surrounding the eye that pulls the cheek up while slightly lowering the brow and creating crow's feet in the eye corners.

The work of Duchenne influenced Darwin's (1872) writings on the evolutionary origin of emotional expression in man and animals. Darwin (1872) first proposed that expressions that successfully communicate inner states and traits to observers, once voluntary and under control of the will, become habitual and less amenable to conscious manipulation. Second, he observed antithesis in opposing expressions; movements associated with opposing emotions are likely to be opposite in nature. For example, a smile upturns the lip corners while a frown turns the lip corners downward, thus expressing polarized emotions with opposing movements. Last, Darwin postulated that serviceable communicative signals, through successive generations, become innate and uncontrollable movements controlled by the nervous system outside conscious awareness.

These expressions, described by Darwin (1872), may be referred to as *basic emotions*. More recently, Izard (2007) described basic emotions as natural kinds (i.e., categories that occur

naturally and are not artificially created by humans) and as having the following components. First, basic emotions involve expressive behaviours that derive from evolutionarily adapted neurobiological systems. These behaviours are invariant, emerge early in development, and can be recognized by observers regardless of the bearer's age or culture of origin. Darwin (1872) too suggested that innate emotional expressions are invariable across culture. He distributed surveys to various European travellers who had contact with native tribes around the world, asking them to describe the expression of emotion by foreign groups in order to gather data on his claim of shared evolutionary expressions. Surveys reaching as far as the Nass River of British Columbia, Canada, substantiated his hypothesis. Similarly, Ekman, Sorensen, and Friesen (1969) surveyed a series of literate and preliterate societal groups (from the United States, New Guinea, Borneo, Japan, and Brazil) and found that all were able to recognize basic emotions expressed in a set of standardized photographs. Further, recent research suggests that the categorical classification of discrete basic emotions does not even require language (Sauter, LeGuen, & Haun, 2011).

Izard (2007) further specified that a basic emotion does not include complex, higher-order processing (i.e., thought or judgment). In other words, basic emotions are evoked spontaneously and without careful conscious deliberation about the antecedent circumstances. Basic emotions also are associated with a unique and innate feeling component, which both regulates and motivates cognition and action, prompting the bearer to respond to the emotion-inducing situation in an adaptive manner. Indeed, contemporary research suggests that congenitally blind athletes respond to victory and defeat with the same spontaneous facial expressions as sighted competitors, suggesting that some basic emotional facial expressions are innate, not learned (Matsumoto & Willingham, 2009). These facial expressions also are accompanied by adaptive non-verbal behaviours; for example, the loser is likely to adopt a

constricted (i.e., cringing) posture, shielding their body from potential further injury by a higher-status rival (Tracy & Matsumoto, 2008).

Although Darwin (1872) devoted very little attention to the issue of deceptive expressions, his observations have contributed greatly to the study of emotional facial cues to deception (Ekman, 2009). He suggested that some facial muscle actions associated with emotion cannot be completely inhibited when the corresponding emotion is felt. Further, he suggested that certain facial muscles are likely to fail when attempts are made to engage them voluntarily during emotional simulation. Collectively, these propositions form the *inhibition hypothesis* (Ekman, 2003a) – a theory central to the research presented in Chapters 2 and 3 of the present dissertation. Particularly during consequential acts of deception when motivation is high and cognitive load is heavy, this proposal provides enormous potential for the detection of falsified emotion. Specifically, it is expected that those facial muscles least under cognitive control will be most likely to fail. While muscles of the lower face are contralaterally innervated, and under fine voluntary control serving tasks such as chewing and talking, the upper face is ipsilaterally innervated and less under volitional control (Rinn, 1984). Thus, it is the upper facial muscles that are expected to fail first during emotional deception (e.g., Hurley & Frank, 2011).

Observations and experimentation by Duchenne (1862) and Darwin (1872), in combination with contemporary knowledge of facial innervation (Rinn, 1984), highlight particular muscles that are least under conscious control. These muscles are most likely to leak genuine emotion and are unlikely to be recruited during simulated emotional expressions. Specific to the expression of sadness, Darwin noted that the *corrugator supercilli*, *procerus* or *pyramidalis nasi,* and *depressor supercilli* in the forehead are beyond conscious control (refer to Figure 1). He noted that there are few persons who can engage these muscles of the forehead to

appear falsely distressed without practice, while some never can. The movement, he speculated, serves to protect the eyes from increased pressure associated with infantile fits of crying. While we may, by age and learned cultural norms, suppress violent tears from escaping, our face nonetheless prepares for such a dramatic display. Further, Darwin observed that contraction of the *depressor anguli oris*, pulling the mouth into a frown precedes tears in both children and adults. He presumed that the opening of the mouth in this manner prepares for subsequent fits of screaming in distress and occurs outside of conscious control even if the tears and screaming may be inhibited.

1.4.3 Contemporary research: Emotional arousal as a cue to deception.

Much of what we presume to know about the nature of facial indicators of specific deception emotions is based upon the observations and writing of Paul Ekman (e.g., Ekman, 1992; Ekman & Friesen, 1969, 2003), with apparent insight borrowed from Darwin (1872). Ekman and Friesen (2003) suggest that deceptive facial expressions are likely to be revealed by the appearance of the expression (morphology), timing (i.e., onset, offset, and duration of the expression), and location of the expression in conversation, with these characteristics revealing one's inner emotional state. Specifically, they contend that the muscles of the forehead are not likely to be deliberately engaged during falsified sadness or fear. Further, the narrowing of the lips in anger cannot be concealed despite concerted attempts to mask or neutralize genuine rage; however, the expression may be easily simulated. Similarly, genuine disgust is expected to be revealed by an upper lip raise, but it too easily may be falsified in the absence of true feelings of distaste. The morphological aspects of surprise also are considered to be easily feigned, but, in this instance, the false face may be revealed by inappropriate timing – a delayed onset and extended duration relative to genuine astonishment. While these observations are astute and

grounded in evolutionary theory, they are largely untested hypotheses – the subject of much speculation and acclaim, but little peer-reviewed empirical investigation.

Surprisingly, even the inhibition hypothesis, upon which much subsequent emotional facial deception research is based, had not been empirically tested until recently. Ekman (2003a) noted: "I am embarrassed to confess that because it seemed so obvious, we never quantitatively tested Darwin's inhibition hypothesis" (p. 208). As such, it was – until recently – not established whether the face would leak signals of deception during falsified facial expression. Further, little empirical work exists to substantiate claims that microexpressions – $1/25^{th}$ to $1/5^{th}$ of a second, full-face, expressions that reveal one's true emotions, quickly suppressed by a liar (Ekman & Friesen, 1969) – are a valid cue to deception despite uncritical acceptance of the notion in scientific and popular media arenas (Adelson, 2004; Duenwald, 2005; Schubert, 2006). To clarify, these concepts are intrinsically tied; microexpressions are simply emotional leakages lasting a brief, and strictly defined, period of time.

Although the identification of microexpressions commonly is attributed to Ekman (e.g., Broadhurst & Cheng, 2005; Vrij & Mann, 2004), this phenomenon was first described by Haggard and Isaacs in 1966. During an examination of videotaped interviews with psychiatric patients, they discovered that momentary emotional facial expressions could be detected when the video footage was slowed to four frames per second (fps); expressions that were not recognizable to the naked eye in real time footage (24 fps). Haggard and Isaacs (1966) found that about 2.5 times the number of emotional expressions were detected at 4 fps relative to coding conducted at the rate of 24 fps. These "micro-momentary expressions" (MMEs) typically lasted about $1/5^{th}$ of a second, and often were embedded between other emotional facial expressions, but were highly variable in frequency. For example, one of the patients exhibited 98 MMEs in

one hour of interviewing and only 3 MMEs in another hour, which was marked by long silences, "stubbornness," and few expressions of any kind. MMEs appeared to vary in frequency based on both individual and situational factors. However, the strength of Haggard and Isaacs' (1966) observations is tempered by the limitations of their methodology. They presented data from only two case study patients with subjective coding of MMEs over the course of a psychotherapy interview.

These brief expressions often were observed in the "context of conflict" (Haggard & Isaacs, 1966, p. 161), leading the authors to propose that MMEs may be an outlet for unacceptable id impulses. Abandoning this psychodynamic proposition, Ekman and Friesen (1969) suggested that MMEs might reflect deceptive emotional presentations. They went on to speculate that "if there is a brief but relatively complete display of affect, then the micro display may provide leakage (a cue betraying the deception being portrayed). Such micro displays are often followed by or covered by simulated, antithetical, macro affect displays and the untrained observer will usually miss or minimize micro displays" (p. 97). Ekman and Friesen (1975) later redefined "microexpressions" as leakage of a deceiver's true emotion in the form of a full-face expression lasting between $1/25^{th}$ to $1/5^{th}$ of a second. They further argued that these short-lived emotional expressions are not under conscious control and may even occur during self-deception.

The majority of empirical work examining differences in genuine and deceptive emotional expression contributed by Ekman and his colleagues has focused on happiness and the observations of Duchenne (1862), later reiterated by Darwin (1872). Ekman, Davidson, and Friesen (1990) confirmed that smiles of enjoyment are more likely to include muscular activation around the eyes, creating crow's feet in the eye corners, relative to falsified

expressions of happiness characterized only by the upturned mouth. Further, Ekman, Friesen, & O'Sullivan (1988) established that smiles masking feelings of disgust were more likely to include subtle leakage of discordant emotions. Similarly, Hess and Kleck (1990) examined deliberate (masked) versus spontaneous (genuine) facial expressions of happiness and disgust, finding that emotional masks were shorter and more turbulent – with more phases and/or irregularities – than genuine expressions. Thus, while long-held assumptions regarding deceptive expressions of happiness have found empirical support, contentions surrounding the remaining universal emotional expressions (sadness, disgust, fear, surprise, anger, contempt; Ekman & Friesen, 2003; Matsumoto, 1992) have been afforded substantially less attention. However, analyses of deceptive mock interrogations have revealed the leakage of fear and disgust (Frank & Ekman, 1997), and despite instructions to suppress eyebrow raises or smiles during similar interrogations participants often were unsuccessful (Hurley & Frank, 2011). In sum, while the face does appear to reveal some aspects of deception, the long-held assumption explaining this phenomenon (i.e., the inhibition hypothesis) had seen little direct empirical investigation prior to our investigations of the topic.

In our preliminary examination of the tenets of the inhibition hypothesis, we examined the nature of facial expressions accompanying four types of falsified or concealed universal emotions: happiness, sadness, fear, and disgust (Porter & ten Brinke, 2008). Participants viewed powerful emotional images, responding with a genuine or convincing but false expression. Blind (to veracity) frame-by-frame (each $1/30^{th}$ second frame for more than 100,000 frames) coding of nearly 700 videotaped expressions lent credibility to Darwin's ideas. The involuntary leakage of emotions was ubiquitous in a way; no-one was able to falsify emotions without such betrayals on at least one occasion (although most were sometimes successful deceivers). Involuntary expressions were rarely expressed across the entire face, instead appearing in the upper or lower

face only (e.g., a smirk when attempting to appear sad) and often lasted up to a second in duration. Further, participants were less successful at adopting false displays of negative emotions than a false "happy face." Microexpressions occurred rarely; only 14 emotional expressions lasting between $1/5^{th}$ and $1/25^{th}$ of a second appeared over the course of the 697 analyzed expressions. Contrary to Ekman and Friesen's (2003) description, these brief expressions did not include the entire face and sometimes occurred during genuine emotional displays (see also Porter, ten Brinke, & Wallace, 2012).

Bolstered by our findings and eager to conduct further empirical examinations of Darwin's keen observations after the publication of Porter and ten Brinke (2008), we decided to embark upon the most comprehensive program of study of genuine and falsified facial expressions ever conducted. Replicating and extending our initial work, we next planned to examine the impact of emotional intensity on the likelihood of leakage during deceptive expressions. True to the suggestion implicit in Darwin's (1872) inhibition hypothesis, genuine emotion was particularly difficult to suppress – and more likely to be revealed on the face – when it was strong, relative to weaker emotional states (Porter et al., 2012). However, the presence of microexpressions again was rare and sometimes associated with genuine expressions. Thus, while support continued to gather for Darwin's inhibition hypothesis, the search for microexpressions, specifically, was less successful.

Utilizing data gathered in our two initial studies of emotional deception (i.e., Porter & ten Brinke, 2008; Porter et al., 2012), we examined individual differences in ability to deceive in this context. Specifically, we hypothesized that psychopathic personalities, associated with affective deficits, and emotionally intelligent individuals, with a healthy emotional life, both would be proficient deceivers, but in different ways. As expected, emotionality – the ability to perceive

and express emotion – was positively correlated with the expression of emotion consistent with the intended, deceptive emotional display. In contrast, the interpersonal manipulation facet of psychopathy was related to reduced leakage of inconsistencies during falsified facial expressions (Porter, ten Brinke, Baker, & Wallace, 2011). The implications of these findings are not trivial; psychopathic offenders are known to be master manipulators, receiving reduced sentences and earlier conditional releases than non-psychopathic offenders despite their higher risk for re-offense and poorer treatment prognosis (Hakkanen-Nyholm & Hare, 2009; Porter, ten Brinke, & Wilson, 2009).

These lenient decisions, in part, may be due to proficient emotional deception by the psychopathic offender, including falsified displays of remorse for his or her actions and empty promises not to repeat such behaviour in the future. While it is known that falsified displays of remorse are associated with greater emotional turbulence (i.e., presence of more universal emotions, and a sequence of expressions that less often return to neutral between positive and negative emotional expressions), it is not clear how psychopathic individuals behave in this context (ten Brinke, MacDonald, Porter, & O'Connor, 2011). However, based on the findings of Porter, ten Brinke, Baker, and Wallace (2011) and an understanding of the inhibition hypothesis, it is reasonable to expect psychopaths to be shrewd deceivers in this situation, with less leakage of genuine emotion discordant with the lie (since they lack the capacity to experience strong emotions, to be leaked) resulting in less turbulent, more controlled, and more convincing crocodile tears.

Although less informative than emotional expression, blink rate also may serve as a marker of general arousal levels. Porter and ten Brinke (2008) found that, in addition to emotional "leakage," blink rate appears to share a complex relationship with emotional

fabrication. Specifically, blink rate increased during emotional masking and decreased during emotional neutralization, relative to genuine expressions. Similarly, blink rate decreases during deceptive denials, presumably associated with the neutralization of one's true emotions about the covertly-held knowledge; this finding appears both in laboratory and real world, high-stakes interrogations (Leal & Vrij, 2010; Mann, Vrij & Bull, 2002; ten Brinke, Wallace, & Porter, 2011).

Growing support for the emotional arousal theory of deceptive behaviour and tenets of the inhibition hypothesis specifically, provides a solid foundation for further laboratory and field studies with applied potential. However, empirical investigations of facial indicators of deception among forensic samples and in high-stakes situations are lacking. Such research is necessary to ensure the informed and responsible application of facial analysis in consequential investigations.

1.5 Behavioural Consequences of Cognitive Load

> *They lay bare the foundations of a man's thoughts with curious distinctiveness, and exhibit his mental anatomy with more vividness and truth than he would probably care to publish to the world.* (Galton, 1879, p. 60)

Sir Francis Galton made this statement in 1879 regarding responses to word association tasks. He reasoned that when guilty suspects are confronted with words associated with the crime in question, their mental conflict related to blocking the genuine response and the creation of a non-incriminating answer would result in delayed reaction times, repeated responses, and uncoordinated movements. These hypotheses and early word association experiments (e.g.,

Langfeld, 1920) were the first formal investigations of what we now refer to as the cognitive load theory of deceptive behaviour.

The cognitive load theory is related to the mentally taxing situation experienced by the liar, associated with several potential cognitive challenges (e.g., Porter & Yuille, 1995). First, the preparation of the lie may be demanding; guilty murderers must construct an alibi that sounds plausible, is consistent with facts known to police, and avoids implicating themselves in the crime. Further, because liars are less likely to take their credibility for granted (i.e., illusion of transparency; Gilovich, Savitsky, & Medvec, 1998), they are likely to monitor their speech, body language, and facial expressions more closely than truth-tellers, amplifying the cognitive demand associated with providing a deceptive alibi (Vrij, 2008a). Indeed, functional MRI research has found that deception is associated with increased activity in the "higher order" or "executive" centres of the brain (e.g., prefrontal and anterior cingulate cortices), relative to truth-telling (Abe, 2011; Spence et al., 2004). In fact, these higher order centres of the brain appear to be central to the production of lies, with deception frequency being positively correlated with the volume of the neocortex across species (Bryne & Corp, 2004).

Behavioural manifestations of increased cognitive load associated with activity in these brain centres include a slowed speech rate, longer pauses, and increased speech hesitations, allowing the liar more time to construct a plausible story (Vrij, 2008a). The difficulty of this task also may result in an increase in speech errors, relative to the truth-teller who simply must recall his/her past experience. Further, the liar may neglect his/her body language while preoccupied with the challenges of deception. As such, deception generally is associated with fewer hand and arm movements that naturally accompany speech to illustrate the narrative content (at least in low-stakes laboratory situations with student participants; DePaulo et al., 2003; Sporer &

Schwandt, 2007). Further, reductions in blink rate are associated with cognitively demanding tasks and thus, while blink rate has also been attributed to emotional arousal, cognitive load may account for reductions (but not increases) in blinking behaviour during deception (Leal & Vrij, 2010). Such behavioural cues may be particularly evident when deceivers are presented with unanticipated questions. Because deception is difficult, deceivers often attempt to prepare their false narrative in advance; however, unanticipated questions can catch liars off guard, forcing them to create a false but coherent and believable response on the spot (Vrij et al., 2009).

1.6 Behavioural Consequences of Attempted Behavioural Control

The cognitive load experienced during deception may be attributed, in part, to the liar's attempts to consciously control his/her behaviour in an effort to appear honest. While truthful individuals often take their credibility for granted, believing in illusions of transparency or holding a belief in a just world, liars may assume the difficult job of creating an impression of honesty to accompany their falsified statement (DePaulo & Kirkendol, 1989; Porter & Yuille, 1995). Thus, deceptive perpetrators are likely to be keenly aware of their body language and manipulate their behaviour in ways that they believe will exude credibility. However, these attempts are likely to fail for at least three reasons. First, some behavioural channels are outside of conscious control. As noted by Darwin (1872) and discussed earlier, facial expressions serving a communicative purpose have become innate and involuntary signals of our true emotions. Thus, while one might attempt to control facial muscles to be consistent with the lie being told, they are likely to betray the deceiver's true feelings. Second, failures to successfully replicate truthful behaviour may occur because the liar does not have an adequate understanding of how he/she appears when truth-telling. In other words, because truth-tellers generally do not monitor their behaviour, they do not store a mental representation of how they appear when

truthful, for subsequent referral during future lies. Third, attempts to control behaviour may be overly vigourous. Liars may overcompensate in their efforts to avoid common misconceptions about deceptive behaviour.

A decrease in the use of "illustrators," controllable hand and arm gestures, is among the most reliable effects found for body language cues and potentially occurs because liars go overboard in avoiding fidgeting behaviours (DePaulo et al., 2003). Although a consistent finding among student participants in low-stakes situations, caution is warranted in extending existing relevant findings to high-stakes lies, criminal populations, or other skilled deceivers. Both anecdotal and empirical evidence suggests that the direction and magnitude of deviation from baseline illustrator use is contingent on individual differences and contextual variables. Some sophisticated liars appear to use illustrators in an active way to enhance their credibility and/or distract attention from their fallacious message, particularly during high-stakes lies. Bill Clinton literally pointed the finger at the American public as he vehemently denied having a sexual relationship with Monica Lewinsky, later admitting that the allegations were in fact true. Nazi Adolf Eichmann showed a similar pattern of deceptive behaviour, using dramatic illustrators during deceitful statements during his interrogations (see Porter & Yuille, 1996). Increased hand/arm movements also appears to be related to personality variables; studies with criminal populations scoring high on psychopathic and anti-social personality traits suggest that these skilled deceivers also may use more movements (e.g., illustrators, self-manipulators) to distract the receiver from inadequacies of the false message (DePaulo et al., 2003; Klaver, Lee, & Hart, 2007; Porter, Doucette, Woodworth, Earle, & MacNeil, 2008). Thus, while the broad literature on low-stakes deception suggests a reduction in illustrators, high-stakes lies and those by skilled deceivers may show the opposite pattern. Despite the complex relation between controllable

body movements and credibility, it is clear that deviations from baseline gesture use should arouse suspicion in the observer (Porter & ten Brinke, 2010).

1.7 Behavioural Consequences of Psychological Distancing

Because lies in forensic contexts typically involve the production of verbal statements, researchers have been interested in the qualities of deceptive narratives and their manner of delivery for many years. Both empirical and anecdotal evidence suggest that (relative to other channels) there is much value in attending to language in catching liars (e.g., Porter & Yuille, 1995; Vrij, 2008b). Resting on the hypothesis that the verbal content of statements arising from experience will differ from those only imagined, Criteria Based Content Analysis (CBCA) represents a standardized and empirically-validated approach to examine the verbal content of a statement of questionable credibility. This approach (not unlike Reality Monitoring; Johnson & Raye, 1981) primarily considers cognitive processes revealed by the liar's story: quantity of details, contextual embedding, reproduction of conversation, and unstructured accounts are among the most highly supported criteria (Akehurst, Manton, & Quandte, 2011; Steller & Kohnken, 1989; Vrij, 2005, 2008b). While these approaches have much to offer the lie detector, they require a lengthy statement for analysis and do not account for the indicators of deceit revealed by specific linguistic choices made by the liar (Porter & ten Brinke, 2010). Indeed, the liar's words are rich with linguistic cues to his or her inner psychological state. In a recent examination of murderers' language, psychopathic offenders were more likely to use cause-and-effect descriptors, less intense and pleasant emotional words, focus on material needs, and avoid reference to social needs (Hancock, Woodworth, & Porter, 2011). These subtle patterns in word choice unconsciously reveal the psychopaths' affective deficits and rational nature.

> *A suppression of a previous intention to say something is the indispensable condition for the occurrence of a slip of the tongue.* (Freud, 1922, p. 52)

Freud would conceptualize the slip of the tongue during a deceptive statement to be an indication of a struggle between two mental forces – an underlying wish to be truthful, thus releasing one's self from the cage of deceit, and the necessity to hide this information from the world in fear of retribution. The unconscious release of subtle information has been proposed to lie in the linguistic choices of deceptive speakers too. For example, in missing person cases, innocent individuals generally refer to the missing person in the present tense, reflecting their assumption that the missing person is still alive (Adams, 1996). The use of past tense language in this context suggests that the pleader is deceptive and holds covert knowledge of the victim's fate; before her body was found, Scott Peterson described his missing wife in this way: "God, the first word that comes to mind is, you know, glorious…She was amazing. She is amazing" (Ryan, 2004). Such tense patterns (among other cues including denials, pronoun use, structure of the statement, etc.) are considered in the verbal veracity tool Scientific Content Analysis (SCAN), developed by former Israeli polygrapher Avinoam Sapir. Despite its face validity and the credibility widely granted to SCAN by investigators around the world, its validity is contentious (Porter & Yuille, 1996; Nahari, Vrij, & Fisher, 2011; Smith, 2001). Criticisms of the tool include its lack of theoretical coherence, standardization, and empirical support (Vrij, 2008a). However, several of the items considered in this method may be subsumed under the theoretical umbrella of psychological distancing and may be objectively coded using linguistic software, to the benefit of deception detectors.

Attempts to create a psychological distance between the liar and the truth – potentially in a non-conscious effort to increase the ease of deception – may result in fewer emotional words,

pronouns, mitigated descriptions of events, or even a complete omission of important details. In a murder case on which the author (assisting Dr. S. Porter) was consulted, the suspect (who was ultimately convicted of murder) admitted to a vaguely-defined argument with his estranged spouse – "a small chat … a little fight" – with the victim on the morning of the crime. Porter and Woodworth (2007) compared the narratives of homicide offenders with official reports, finding that offenders in general and psychopaths, in particular, were likely to minimize the extent of their planning and omit major crime details while maintaining a seemingly credible report. In addition, the relatively recent development of computerized linguistic software (e.g., Linguistic Inquiry and Word Count, LIWC; Pennebaker, Francis, & Booth, 2001) has allowed for objective coding of verbal leakage. Specifically, liars studied to date tend to use fewer first-person pronouns (possibly to avoid accepting responsibility) and more negative emotion words such as *hate* and *sad* (possibly due to feelings of guilt) (Tausczik & Pennebaker, 2010). Online dating profiles that stretch the truth to attract potential mates include fewer first-person pronouns and emotional words (Toma & Hancock, 2012). Research in which participants wrote about their views on personally-significant topics (e.g., abortion) indicated that deceptive and truthful narratives were discriminated by LIWC-coded variables with a mean accuracy of 67% (Newman, Pennebaker, Berry, & Richards, 2003). While these findings were derived from non-forensic samples, Bond and Lee (2005) obtained similar levels of accuracy in predicting the veracity of statements by incarcerated offenders telling lies about a video they had recently watched. Although this linguistic approach to measurement of psychological distancing is promising, further research with forensic samples and high-stakes lies is necessary to establish the utility of linguistics as an applied deception detection tool.

1.8 Multiple Cue Approach

It is clear that there is no Pinocchio's nose, no silver bullet behavioural cue that will always reveal a liar. However, research reviewed here has highlighted some potentially valuable non-verbal, facial, and verbal cues to deception. To date, verbal cues to deception have received the most research attention and consistent support, leading Vrij (2008b) to advocate a shift of attention to verbal cues in police practice in an attempt to increase accuracy and reduce lie biases associated with non-verbal behaviour stereotypes. Porter and ten Brinke (2010), however, advocated a multiple-cue approach to deception detection, contending that body language and facial analysis – when properly utilized in conjunction with verbal cues – can further enhance lie detection ability. We argued that while the presence of a single behavioural cue may not provide reliable evidence for deception, the co-occurrence of multiple cues from words, body, and face should provide the lie catcher with increased confidence that deception has occurred, particularly when those cues are associated with various theories of deceptive behaviour (see also Vrij, Granhag, & Porter, 2011).

The notion of a multiple-cue approach is implicit in standardized approaches to credibility assessment. For example, the CBCA contains 19 criteria with varied levels of empirical support; however, when combined, these criteria can reliably discriminate between genuine and deceptive statements with a level of accuracy around 70% (Vrij, 2005; 2008a). While published studies of body language or facial cues to deceit rarely include prediction models, the few studies that do further demonstrate the advantage of including multiple cues in one's assessment process. Leal and Vrij's (2010) recent examination of blink rate as a cue to guilty knowledge found that this single cue could correctly classify 75% of liars and 77% of truth-tellers. While impressive, these accuracy rates are lower than those reported by Ekman,

O'Sullivan, Friesen, and Scherer (1991) who included the frequency of genuine (Duchenne) smiles, masking smiles (falsified expressions of happiness including subtle cues leaking discordant emotions), and voice pitch to reach an accuracy rate of 86.4%. Importantly, this model includes predictors that tap both prongs of Darwin's (1872) inhibition hypothesis, as well as a more generalized measure of arousal – predictors that each accounted for unique variance discriminating genuine and deceptive participants. The addition of behaviours related to cognitive load, psychological distancing, or attempted behavioural control may serve to further enhance classification accuracy.

While the lie catcher must be cognizant of the influence of contextual and individual difference variables, it is clear that knowledge of empirically-validated cues to deception (preferably in relation to comparative, baseline, genuine behaviour) can result in more accurate assessments of credibility. Porter et al. (2000) demonstrated that a holistic approach addressing deception myths, warning of the pitfalls of detecting lies with common sense or intuition, and describing the "most" and "least" reliable verbal and non-verbal behavioural manifestations of lying, combined with practice and feedback led to an improvement in deception detection of parole officers. After two days of intensive training, parole officers' accuracy rose from 40.4% at baseline (significantly below chance) to 76.6%. Abbreviated versions of this training program, lasting only two hours, also have produced modest (12% change), but statistically significant, increases in participants' ability to detect deception in videotaped narratives (Porter, Juodis, ten Brinke, Klein, & Wilson, 2010). Further, there is evidence that emotional expression detection training can facilitate deception detection; a positive relationship exists between the ability to recognize subtle signals of emotional facial expression and accuracy in detecting emotional lies (Warren, Schertler, & Bull, 2009).

1.9 Motivational Impairment

Although the majority of empirical research on deceptive behaviour has examined student populations telling low-stakes lies of little consequence (DePaulo et al., 2003), deceptive behaviour can depend heavily on the potential outcome for the liar. In cases where the cost of failure to deceive is great, it is expected that the potential for "leakage" and the saliency of behavioural "leakage" will be increased (the "motivational impairment effect"; DePaulo & Kirkendol, 1989). Supporting this notion, DePaulo et al. (2003) found that several cues to deception were exacerbated in high-motivation scenarios. Further, motivated liars were less successful deceivers when observers could observe their non-verbal behaviour, suggesting that leakage in this domain revealed their duplicity (DePaulo et al., 1988).

Thus, while little white lies that promote social cohesion most often evade detection, motivated lies of consequence, like those relating to survival and reproduction, are more likely to be detected. Consider the unfaithful wife, attempting to account, for her husband, her whereabouts during a recent tryst. Or the husband publicly pleading for the safe return of his missing wife who he has murdered; he desperately tries to appear sad while stifling his relief that the deed is done, or his disgust as he recalls the scene of the crime. Each of these liars must concurrently monitor his/her body language, facial expressions, and stories, all the while considering the potent consequences of getting caught (Porter & ten Brinke, 2010). This multi-faceted task is likely to over-extend the finite cognitive resources available to engage in deception and increase the likelihood that behavioural indicators of duplicity will be revealed. Indeed, it appears that high-stakes lies, or deception under cognitive load, allows the observer to discriminate lies above the level of chance (O'Sullivan et al., 2009; Vrij, Mann et al., 2008). However, lie detection, even in high-stakes situations, remains a fallible process – particularly

without empirically-validated training (e.g., Bond & DePaulo, 2006; Shaw, Porter, & ten Brinke, 2011).

Although it is expected that cues to deception will be inflated during high-stakes lies, there exists a paucity of research on these lies. This is likely due to the difficulty of obtaining footage of such lies and determining ground truth in these cases (Vrij, 2008a). In the only studies to date to examine behavioural cues to deception in real-life police interviews, Vrij and colleagues (Mann, Vrij, & Bull, 2002; Vrij & Mann, 2001b) compared murderers' behaviour across genuine and deceptive question responses. Liars appeared to blink less, engage in more pauses and use fewer hand/finger movements. Interestingly, Vrij (2008a) also noted that Ian Duntley, a British caretaker who murdered two schoolgirls and spoke on television about the girls prior to his arrest (a case included in Chapter 2 of the present dissertation), engaged in long pauses and repeated words during deceptive aspects of his police interview. Despite this convergence of findings, further empirical work on high-stakes deception clearly is necessary prior to the application of these findings in such consequential settings. Indeed, Vrij (2008a) noted the lack of research in the area and Porter and ten Brinke (2010) recommended that researchers afford greater empirical attention to high-stakes lies.

1.10 The Current Dissertation

Interested in furthering the study of high-stakes lies, in 2006 we acquired, from Aldert Vrij, the videos that he showed police officers to establish that they were no better than chance at detecting high-stakes, real-world lies (Vrij & Mann, 2001a). This study served both to (a) shatter the often-used argument by law enforcement that experimentally-derived deception detection paradigms (i.e., judging videotaped undergraduate participants) do not produce accurate assessments of their ability to detect real-world deceit and (b) inspire the present dissertation.

Vrij and Mann's (2001a) videos included five emotional pleas to the public. Pleaders asked for assistance in the return of a missing relative or information leading to the arrest of whoever had murdered his/her relative. In reality, these pleaders were guilty of murdering the missing/recently deceased relative and were executing an elaborate, high-stakes lie. Although Vrij and Mann (2001a) were interested in police deception detection accuracy and not the behavioural presentation of these individuals, such footage offers a unique opportunity for the analysis of behavioural consequences related to high-stakes emotional deception. The current dissertation involved collecting footage of a large number of genuine and deceptive pleaders from around the globe and determining ground truth in each case. Taking advantage of these novel publically-available videos, this dissertation details the most comprehensive analysis of deceptive behaviour to date, hereby contributing to the literature, a critical study of high-stakes liars and the first ever empirical investigation of behaviour exhibited by deceptive (relative to genuine) pleaders.

First, a comprehensive examination of speech (verbal/linguistic), body language and emotional facial cues related to the emotional arousal, cognitive load, attempted behavioural control, and psychological distancing theories of deceptive behaviour was conducted. In addition to examining the presence of each cue to deception in isolation, the validity of the multiple-cue approach advocated by Porter and ten Brinke (2010) was tested. It was expected that a combination of cues – particularly those attributed to different theories of deceptive behaviour – would contribute unique explanations of the variance between genuine and deceptive pleaders. This research is presented in Chapter 2 with permission from *Law and Human Behavior* where it currently is in press.

Complementing this work, and further explicating the information revealed by the faces of genuine and deceptive pleaders, the utility of facial analysis at the muscular level was the second focus of the present dissertation. In accordance with the astute observations of Charles Darwin (1872) in combination with a contemporary understanding of facial innervation (Rinn, 1984), it was expected that specific muscles would indicate genuine distress, and also reveal insincere pleaders. This work is detailed in Chapter 3 and currently is in press in *Evolution and Human Behavior*.

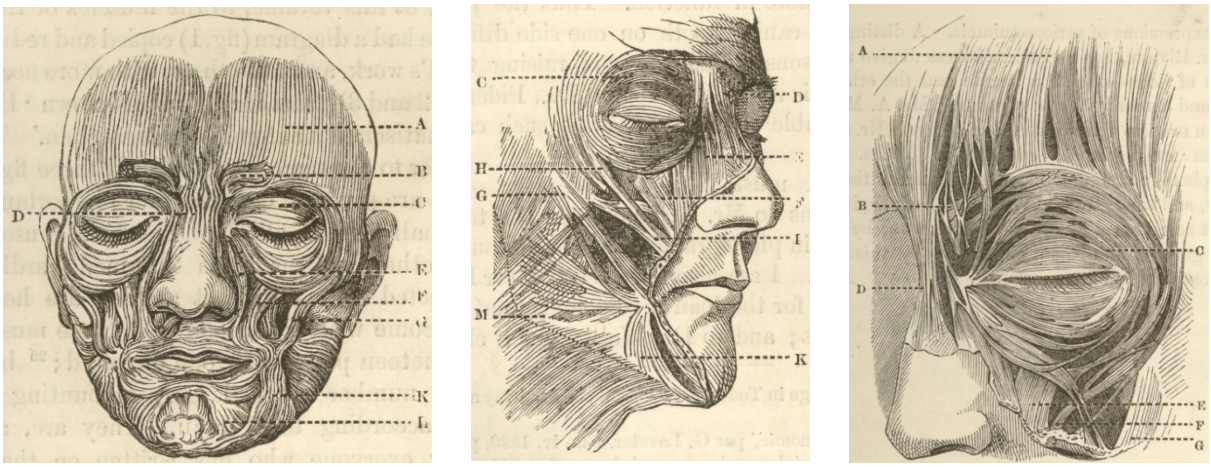

Figure 1.1 Muscular anatomy of the human face (Darwin, 1872). Relevant muscles include: A (*frontalis*), B (*corrugator supercilli*), C (*orbicularis oculi*), D (*procerus* or *pyramidalis nasi*), G (*zygomatic major*), and K (*depressor anguli oris*). Reproduced with permission from John van Wyhe (2002).

2. Chapter Two. Cry Me a River

2.1 Synopsis

Interpersonal deception has evolved to be a common, fundamental aspect of human social interaction. Despite people's experience with deceiving and being deceived by others, lies are notoriously difficult to detect; most observers - including relevant professionals such as law enforcement - do no better than flipping a coin (e.g., Ekman & O'Sullivan, 1991; Vrij & Mann, 2001a; see Vrij et al., 2011). Nonetheless, observers typically are confident in their ability to spot signs of deception and threat, potentially leading to a range of consequential mistakes, from undetected terrorists to wrongful convictions (Weinberger, 2010). Although humans are more proficient liars than lie detectors, deceivers too face a difficult task. In particular for "high-stakes" lies, a deceiver must construct a consistently detailed story and communicate the deceptive information - via facial expression, speech, and body language communication channels - in a way that will maximize his/her apparent credibility.

Although the majority of studies on deceptive behaviour has examined low-stakes lies of little consequence (Porter & ten Brinke, 2010), deceptive behaviour can depend heavily on the potential outcome for the liar, such that lies of consequence are associated with more salient behavioural signs (the "motivational impairment effect"; DePaulo & Kirkendol, 1989). High-stakes lies can be accompanied by powerful emotions - fear, remorse, anger, or even excitement – that must be inhibited and/or convincingly faked. Consider the husband publicly pleading for the safe return of his missing wife whom he has murdered. He must monitor his body language, mask genuine emotional facial expressions, while creating a believable story and considering the enormous consequences of getting caught. Given the difficulty of this task, "leaked" signals of increased cognitive load, emotional arousal, impression management, and psychological

distancing may reveal the liar's duplicity. The knowledgeable lie detector can take notice of such behavioural leakage, using the existence of multiple indicators of deceit to bolster his/her confidence in a determination of dishonesty. Indeed, Porter and ten Brinke (2010) advocated the multiple-cue approach to lie detection wherein the occurrence of multiple, empirically-validated indicators of deception (or truth) can increase the credibility assessor's confidence in his/her determination.

2.1.1 Consequences of emotional arousal.

The face is the dynamic canvas on which humans express emotional states and from which they infer those of others. However, humans evolved to alter their facial expressions to facilitate deception (Livingstone Smith, 2004). While attempts to feign or inhibit emotional expressions often are successful, it has long been assumed that attention to certain aspects of facial expression can betray such duplicity. As summarized in Chapter 1, Darwin (1872) observed that, "A man when moderately angry, or even when enraged, may command the movements of his body, but…those muscles of the face which are least obedient to the will, will sometimes alone betray a slight and passing emotion" (p. 1104). This statement was inspired by the work of Duchenne (1862) who noted through the experimental use of electrical stimulation that voluntary smiles involve upturned lips (*zygomatic major*), but are not accompanied by activation of muscles around the eyes (*obicularis oculi*), and can reveal a "false friend." Darwin (1872) generalized these findings, hypothesizing that some facial muscle actions associated with strong emotion are beyond voluntary control and cannot be completely inhibited. Further, he proposed that certain facial muscles cannot be intentionally engaged during emotional simulation. Collectively, these two propositions form the *inhibition hypothesis,* a proposal with enormous relevance to human communication (Ekman, 2003a). A related proposition is that

microexpressions – 1/25th to 1/5th of a second, full-face, expressions that reveal one's true emotions, quickly suppressed by a liar – are a valid cue to deception (Ekman & Friesen, 1969).

Despite delayed empirical investigation of Darwin's hypothesis, it finally is gathering scientific support. By examining hundreds of genuine and falsified expressions of universal emotions in the laboratory context, researchers have found that involuntary leakage of emotion is ubiquitous; no one seems able to falsify emotions without such betrayals on some occasions, most often occurring during negative emotional displays (Porter & ten Brinke, 2008). Emotional leakage is more likely to be present, and last longer in masked versus genuine expressions, particularly when suppressing an intense, relative to a weak, emotion (Porter, ten Brinke, & Wallace, 2012). However, unintended expressions generally are subtle and appear in the upper or lower face only (e.g., a smirk when attempting to appear sad), and "microexpressions" are rare. Contrary to Ekman and Friesen's (1975) description, these brief expressions did not include the entire face and sometimes occurred during genuine emotional displays (see also Porter, ten Brinke, & Wallace, 2012). Further, masking one's true emotion is associated with increased blink rate, and neutralizing emotion, with decreased blinking in laboratory and high-stakes settings (Leal & Vrij, 2010; Mann, et al., 2002; Porter & ten Brinke, 2008).

2.1.2 Consequences of cognitive load.

The preparation of a lie is likely to be a mentally taxing task; the guilty murderer must inhibit the truth, construct an alibi that sounds plausible, is consistent with facts known to police, and avoids implicating himself or herself in the crime. In contrast, the truth-teller simply must recall and relate his/her memory for the event in question. Further, because liars are less likely to take their credibility for granted, they are likely to monitor their speech, body language, and

facial expression more closely than truth-tellers, amplifying the cognitive demand associated with providing a deceptive alibi (Vrij, 2008a).

Behavioural manifestations of increased cognitive load include a slowed speech rate, longer pauses, and increased speech hesitations (e.g., *um*, *ah*, *er*), allowing the liar more time to construct a plausible story (Vrij, 2005; Vrij & Mann, 2001b). The difficulty of this task also may result in an increase in speech errors, relative to the truth-teller. Further, the liar may neglect his/her body language while preoccupied with the challenges of deception. As such, deception generally is associated with fewer hand and arm movements that naturally accompany speech to illustrate the narrative content (at least in low-stakes laboratory situations with student participants; DePaulo et al., 2003).

2.1.3 Consequences of attempted behavioural control.

Elements of the cognitive load experienced during deception may, in part, be attributed to the liar's attempts to consciously control his/her behaviour in an effort to appear honest. However, attempts to portray credibility via behaviour are likely to fail for several reasons. First, some behavioural channels are outside of conscious control. As noted by Darwin (1872), those movements least amenable to volitional control may reveal our true emotions and intentions, particularly when cognitive resources are strained. Second, the liar may not have an adequate understanding of how he/she appears when truth-telling and, related to that point, attempts to control behaviour may be overly vigorous. Liars may overcompensate in their efforts to avoid common misconceptions about deceptive behaviour. For example, in attempting not to avert his or her gaze from the recipient's eyes, the liar may stare too long and too hard (Mann et al., 2011). Similarly, efforts to avoid excessive fidgeting may result in reduced and overly controlled, rigid body movements (DePaulo et al., 2003; Vrij, 2008a).

Because body movements are under greater conscious control than facial or verbal indicators of deception, it is possible that reliable findings with student samples do not generalize well to criminal populations or high-stakes situations (Porter & ten Brinke, 2010). While a reduction in illustrator use (hand/arm movements supplementing speech) commonly is related to deception in laboratory settings with student samples, studies with criminal populations suggest that these skilled deceivers do not follow this pattern and instead, may use more movements (e.g., illustrators, self-manipulators) to distract the receiver from inadequacies of the false message (DePaulo et al., 2003; Porter et al., 2008; Klaver, Lee, & Hart, 2007). In a pair of studies examining truthful and deceptive behaviour of criminals in police interviews, no such cues were found to differ across veracity (Mann et al., 2002; Vrij & Mann, 2001b).

2.1.4 Consequences of psychological distancing.

Empirical and anecdotal evidence suggest that (relative to other channels) there is much value in attending to language in catching liars (Vrij, 2008b). While previous research has established the validity of Criteria-Based Content Analysis (CBCA) and Reality Monitoring (RM), based on cognitive theory, these approaches require a lengthy statement for analysis and do not account for the more idiosyncratic indicators of deceit revealed by specific linguistic choices made by the liar (Porter & ten Brinke, 2010).

Attempts to create a psychological distance between the liar and the truth – potentially in a non-conscious effort to increase the ease of deception – may result in characteristically deceptive word usage. Utilizing computerized linguistic software (Linguistic Inquiry and Word Count (LIWC); Pennebaker et al., 2001), laboratory studies have found that liars tend to use fewer first-person pronouns (to avoid accepting responsibility), more negative emotion words (revealing feelings of guilt), and more tentative words such as *maybe* and *perhaps* (avoiding

commitment to the lie) (Newman et al., 2003; Zhou, Burgoon, Nunamaker, & Twitchell, 2004). Given that these cues are presumed to occur outside of the liar's conscious awareness, they are less susceptible to manipulation and thus also appear in lies told by relatively sophisticated deceivers (criminal populations) and in real-world situations (Bond & Lee, 2005; Harpster, Adams, & Jarvis, 2009).

2.1.5 The current study.

The current study investigated the behavioural consequences of high-stakes deception related to each of these theoretical orientations using a unique sample: We examined the videotaped behaviours of a large international sample of individuals emotionally pleading to the public for the return of a missing relative. In approximately half of these cases, the pleader ultimately was determined – via powerful evidence and a guilty verdict in court – to have murdered the relative prior to the public appeal. Honest pleaders are, of course, genuinely and desperately seeking the return of their loved one. Such televised pleas typically include a description of the missing person, the pleader's experience with the recent events, words of thanks to those assisting with the search, and a direct appeal. In the direct appeal, the pleader asks the perpetrator to let the missing person go, the missing person to make contact, or the public to assist search parties. The critical lie, told by deceptive murderers, occurs during the direct appeal wherein they ask for assistance in the safe return of the missing person while harboring knowledge that this request cannot possibly be fulfilled. Thus, although the deceptive pleader plays the role of the concerned relative throughout the entire plea, and behavioural cues differentiating genuine and deceptive pleaders may be present, it was expected that the direct appeal was most likely to reveal cues to deceit.

Pleas were exhaustively coded for behavioural (speech, body language, and emotional facial expression) indicators of emotional arousal, cognitive load, attempted behavioural control, and psychological distancing related to several specific hypotheses.

Hypothesis 1. Relative to genuine pleaders, deceptive murderers were expected to fail in producing convincing sadness/distress expressions, and leak more discordant emotions (i.e., happiness), as a result of their qualitatively distinct emotional arousal.

Hypothesis 2. Increased cognitive load experienced by liars was expected to result in a slower speech rate, the use of fewer words, and increased speech hesitations compared to genuinely distressed individuals.

Hypothesis 3. Attempts by liars to create psychological distance were expected to result in a decrease in pronoun use, emotional words, and an increase in tentative (noncommittal) words by deceivers relative to genuine pleaders.

Hypothesis 4. It was expected that body language under conscious control (i.e., illustrator and facial-manipulator use, gaze aversion) could be successfully maintained by deceivers. However, blink rate – as a potentially controllable but largely involuntary reflex – was expected to increase due to arousal associated with emotional masking relative to genuine emotional expression by truth-tellers.

Hypothesis 5. Complementing this holistic examination of behavioural leakage, it was expected that the multi-cue approach to deception detection would be supported. That is, it was expected that valid cues, particularly those aligned with different theoretical orientations, each would account for unique variance in predicting pleader sincerity (Porter & ten Brinke, 2010).

2.2 Methods

2.2.1 Cases.

Videos of $N = 78$ (35 deceptive) individuals who made televised pleas for the safe return (or information leading to the arrest of an unknown suspect in the murder) of their relative were gathered from news agencies in Australia, Canada, the United Kingdom, and the United States (see Table 2.1 for sample characteristics). The majority of individuals ($n = 52$) included a direct appeal to the perpetrator to let the missing person go, to the missing person to make contact, or to the public for assistance, in their televised plea.

2.2.2 Determination of ground truth.

To ensure the internal validity of this study, we utilized a strict definition of "ground truth" to discriminate deceptive and honest pleaders, similar to the criteria used by Vrij and Mann (2001a). To establish that a pleader was "deceptive" and include him/her in the sample, we required that overwhelming evidence existed to discredit the sincerity of his/her emotional appeal and to establish that he/she had murdered the missing individual. Based on this overwhelming evidence, each of the deceptive individuals eventually were convicted of involvement in the missing individual's death in a criminal court. Evidence included presence of the victim's blood, other DNA (hair, skin), forensic evidence (pollen traces, tire tracks), possession of the murder weapon, security camera footage, phone range or tap information, confessions (not recanted), leading police to the victim's body, incriminating monetary transactions, inadequate alibis, and eyewitness testimony. The majority of cases were classified as genuine or deceptive based on multiple pieces of the above evidence. For example, one husband pleaded for the return of his pregnant wife, but eventually was convicted of her murder

after video surveillance surfaced of him running from the crime scene immediately following the murder and the victim's bloody clothes were found in his closet and vehicle. In another case, a mother confessed to, and provided intimate and non-publicized details of, killing her child after being confronted with admissions she made in phone conversations that were taped by police. In cases of genuine pleaders (n = 43), someone else had been convicted based on similarly overwhelming evidence (n = 34), the relative was found alive with his/her abductor (n = 3), the relative had committed suicide (n = 4), or the missing person was later located in the absence of foul play (n = 2). Table 2.2 provides a summary of evidence utilized to determine ground truth in genuine and deceptive cases.

2.2.3 Coding procedure.

Each video was comprehensively coded (by trained coders, blind to veracity) for behavioural (rate of illustrators, face-manipulations, blinks and proportion of gaze aversion) and emotional facial signals of deception (presence of universal emotional expressions). Illustrators were defined as any movement/gesture of the arms and/or hands, utilized to supplement speech. Facial manipulations were any instance where the participant touched/scratched/covered his/her face (Porter et al., 2008). A blink was coded as any instance in which the eyelids met, and gaze aversion was operationally defined as the proportion of time during which the pleader avoided eye contact with the interviewer, the crowd to whom they spoke, and the video camera.

Emotional facial expressions occurring during each plea were coded using the reliable and valid procedure developed by Porter and ten Brinke (2008) and Porter, ten Brinke, and Wallace (2012). This method was favoured for its relative ease and efficiency over the Facial Action Coding System (FACS; Ekman, Friesen, & Hagar, 2002). Porter and ten Brinke's (2008) coding system is easily translated into practical recommendations for relevant professionals, but

also allowed us to isolate particular facial areas of interest for future, intensive FACS coding (see Chapter 3; ten Brinke, Porter, & Baker, 2011). Training in this method involves facial musculature recognition, memorization of facial action units associated with universal emotions, and identification of universal emotions. This training is based in part on the FACS, with specific attention to those action units associated with variants of universal emotional expressions (Emotion Facial Action Coding System; EMFACS). Universal emotions include happiness, sadness, fear, disgust, anger, surprise, and contempt (Ekman & Friesen, 1975; Ekman et al., 1987). Pictures of Facial Affect (POFA; Ekman & Friesen, 1976) also were studied as prototypical examples of each emotion. Coding involves classifying the emotional expression in each 1/30th-second frame of video in the upper and lower facial regions, independently (see Porter & ten Brinke, 2008 for further information on coding procedures and training). A total of 74,731 frames were coded twice: once for emotional presentation in the upper, and again in the lower, face for a total of 149,462 codes.

Verbal cues including, length of plea in words, speech rate (words per minute), percentage of words that were speech hesitations (e.g., um, ah), pronouns (e.g., I, our), tentative words (e.g., maybe, guess), positive (e.g., happy, joy) and negative emotions (e.g., grief, sad, hate) were calculated using Linguistic Inquiry Word Count software (LIWC; Pennebaker et al., 2001). This text analysis program reliably counts words in psychologically relevant categories and quickly is advancing our understanding of linguistic properties of deception (Tausczik & Pennebaker, 2010).

2.2.4 Coding reliability.

A second trained coder examined body language and emotional cues in 17 (21.8%) videos to assess inter-rater reliability. For all body language variables, coders were highly

reliable (*r*s = .87 - .99). The dichotomously-coded presence (or absence) of emotions in the upper and lower face also were highly reliable (Kappa = .67, $p < .001$, 87.8% agreement; Krippendroff, 1980).

2.3 Results

In a comprehensive and theoretically-driven approach, examining each of the stated hypotheses during the entire plea and direct appeal separately, a series of binary logistic regressions and MANOVAs were conducted. Logistic regressions were utilized to examine the presence/absence of each facial expression (i.e., dichotomous data) as a predictor of pleader veracity (Hypothesis 1). For the continuous verbal and body language variables, MANOVAs were conducted to examine each of Hypotheses 2 through 4, with pleader veracity serving as a between-subjects independent variable. Finally, logistic regression also was performed to test Hypothesis 5.

2.3.1 Complete plea predictors.

Results of a series of logistic regression analyses revealed that significant predictors of deceit included the presence of lower face disgust and the absence of sadness in the upper and lower face, supporting Hypothesis 1. While 14 (40.0%) of liars expressed lower face disgust, only 7 (16.3%) of genuine pleaders did the same, $\beta = 1.23$, Wald $\chi^2 = 5.24$, $p < .05$, O.R. = 3.43. In contrast, liars were less likely to express upper, $\beta = -1.01$, Wald $\chi^2 = 4.53$, $p < .05$, O.R. = .36, or lower, $\beta = -1.34$, Wald $\chi^2 = 6.61$, $p < .05$, O.R. = .26, face sadness/distress. Twenty-four (55.8%) and 21 (48.8%) of truthful pleaders expressed upper and lower face sadness, respectfully. In contrast, only 11 (31.4%) and 7 (20.0%) of deceptive pleaders were able to express the same.

Examining Hypothesis 2, a MANOVA was conducted with veracity as a between-subjects independent variable and speech rate, word count, and proportion of speech hesitations as dependent variables. However, the multivariate test was not significant, $F(3, 73) = 2.10$, $p > .05$, partial $\eta^2 = .08$. In contrast, support was found for psychological distancing in linguistic profiles of deceptive pleaders (Hypothesis 3), $F(4, 73) = 2.69$, $p < .05$, partial $\eta^2 = .13$. Follow-up univariate analyses revealed that deceptive pleaders ($M = 8.44$, $SD = 6.39$) used a greater percentage of tentative words throughout their appeals relative to truth-tellers ($M = 4.84$, $SD = 4.64$), $F(1, 76) = 8.30$, $p < .01$, partial $\eta^2 = .10$. However, the percentage of pronouns, positive emotional and negative emotional words did not differ across pleader veracity, $p > .05$. Finally, Hypothesis 4 was examined by conducting a MANOVA with proportion of gaze aversion and blink rate as dependent variables. Unfortunately, several (controllable) body language cues (i.e., illustrators, self-manipulators) occurred too rarely to be included in meaningful statistical analyses. As expected, the multivariate analysis was not significant, $F(2, 74) = .48$, $p > .05$, partial $\eta^2 = .01$.

2.3.2 Direct appeal predictors.

During the direct appeal portion of the plea (provided by $n = 52$ pleaders), behavioural differences between truth-tellers and deceivers were expected to be more salient, relative to the complete plea. See Table 2.3 for descriptive statistics concerning each variable of interest. Supporting Hypothesis 1, logistic regression analyses revealed that the presence of upper face surprise, $\beta = 1.75$, 95% CI [.62, 3.44], Wald $\chi^2 = 7.52$, $p < .05$, O.R. = 5.73, and lower face happiness, $\beta = 1.20$, 95% CI [.00, 2.82], Wald $\chi^2 = 3.91$, $p < .05$, O.R. = 3.33, each significantly predicted deception. Liars were more likely to express upper face surprise ($n = 15$ or 57.7% liars

vs. n = 5 or 19.2% truth-tellers) and leak lower face happiness (i.e., a smirk) (n = 13 or 50.0% liars vs. n = 6 or 23.1% truth-tellers) compared to genuine pleaders.

A MANOVA, examining the effect of veracity on speech rate, word count, and proportion of speech hesitations during the direct appeal (Hypothesis 2), was significant at the multivariate level, $F(3, 48) = 3.11$, $p > .05$, partial $\eta^2 = .16$. Deceptive pleaders used fewer words (M = 22.47; SD = 14.73) than truth-tellers (M = 45.44; SD = 38.47) in their direct pleas, $F(1, 50) = 9.50$, $p > .01$, partial $\eta^2 = .16$. The multivariate analysis examining Hypothesis 3 provided partial support for the psychological distancing theory, $F(4, 47) = 5.03$, $p > .01$, partial $\eta^2 = .30$. Direct appeals by deceptive murderers also included a higher percentage of tentative words (M = 13.94; SD = 9.50) relative to genuine pleaders (M = 5.45; SD = 6.16), $F(1, 50) = 15.40$, $p > .001$, partial $\eta^2 = .24$. However, there were no differences in the percentage of pronoun, negative or positive emotional words across veracity, ps > .05. Again, several body language cues were too rare for meaningful statistical analyses to be performed; however, analyses examining proportion of gaze aversion and blink rate revealed a significant multivariate effect of veracity (Hypothesis 4), $F(2, 49) = 3.52$, $p > .05$, partial $\eta^2 = .13$. While no follow-up univariate analyses were statistically significant, a trend emerged for deceptive pleaders (M = 41.62; SD = 31.62) to blink at a faster rate than genuinely distressed individuals (M = 29.81; SD = 22.45), $p = .13$.

2.3.3 Multiple cue approach to veracity classification.

To determine how a combination of cues could account for variance discriminating between deceptive killers versus genuine pleaders, a direct binary logistic regression analysis was conducted with all four significant direct appeal cues (presence of upper face sadness and lower face happiness, word count and percentage of tentative words) entered as predictors (Hypothesis 5) (Vittinghoff & McCulloch, 2007).

A test of the full model, relative to a constant-only model, was statistically significant, χ^2 (4, N = 52) = 31.58, p < .001 (see Table 2.4 for statistics describing the contribution of each cue to the complete model). All of the predictors, except the presence of lower face happiness (p = .06), were statistically significant, ps < .05. In general, it appears that cues tapping emotional masking, cognitive load, and psychological distancing all account for unique variance in the prediction of veracity, supporting Hypothesis 5. Further, classification was strong, with 92.3% of genuine and 88.5% of deceptive pleaders correctly classified (7.7% false positive rate; 11.5% false negative rate), for an overall success rate of 90.4%.

2.4 Remarks

Undetected high-stakes deception can hold major consequences for individuals and society. Michael White of Canada was able to convince even his victim's mother when he made a tearful plea for the return of his pregnant wife; in reality, he brutally murdered her only days before. Bernard Madoff, who orchestrated the single largest fraud in history, is described by victims as seemingly "sincere" and "trustworthy." Psychopaths play the part of the rehabilitated, remorseful offender, manipulating their way into shorter sentences and earlier release than their non-psychopathic counterparts (Hakkanen-Nyholm & Hare, 2009; Porter et al., 2009). Building on a large body of literature describing behavioural cues to relatively mundane deception in laboratory settings, the present work offers a great leap forward in building our understanding of the (potentially uncontrollable) behavioural consequences of extremely high-stakes interpersonal deception. Indeed, it appears that involuntary facial and linguistic markers have the capacity to subtly reveal the darkest of secrets. This work also contributes in a significant way to our understanding of human communication, more generally.

2.4.1 Behavioural differences in complete pleas.

Over the course of the entire publicized plea, deceptive murderers were more likely to express disgust and less likely to express sadness than genuine pleaders (supporting Hypothesis 1). These pleas, occurring shortly after the relative's disappearance had been reported to the police, reveal the very different affective experiences of genuine and deceptive pleaders, even during unscripted and varied narratives. Throughout the plea, genuinely distressed innocent relatives display sincere, full-face sadness/distress, both reflecting their genuine emotion and potentially garnering the sympathy and assistance necessary to bring their loved one safely home (Eisenberg & Fabes, 1990). In contrast, the raised upper lip of disgust was more likely to occur during a deceptive, relative to a truthful, plea. While a facial expression cannot reveal its source, we speculate that disgust in this context indicates a visceral reaction to the act of murder that the deceptive pleader engaged in just days before, moral disgust/shame concerning one's actions, or a lingering revulsion for the victim (Chapman, Kim, Susskind, & Anderson, 2009; Ekman, 2003b). In addition to emotional differences, deceptive pleaders used more tentative words throughout the plea (partially supporting Hypothesis 3). In this way deceptive murderers acknowledge that the victim will not be found alive, avoid commitment to the lie, and mitigate the psychological conflict resulting from the discrepancy between their secretly held and outwardly expressed knowledge (Zhou et al., 2004). However, no evidence was found to support verbal indicators of cognitive load over the course of the entire appeal (Hypothesis 2). Further, no body language cues (potentially under careful control of the deceptive pleaders) differentiated complete genuine and deceptive pleas (Hypothesis 4).

2.4.2 Cues to deception in the direct appeals.

The critical lies, told by deceptive murderers, occurred during the direct appeal – requesting help in the safe return of the missing person while harboring knowledge that this request would not be realized. It was generally anticipated that behavioural differences across veracity would be more salient during this portion of the plea than cues averaged across the complete plea, which includes variable content. Indeed, more hypotheses were supported during the direct appeal and larger effect sizes were obtained.

Related to Hypothesis 1, it was expected that indices of unsuccessful emotional masking would be present. The predictive power of the presence of upper face surprise and lower face happiness highlights the importance of contextually relevant, uncontrollable facial muscle actions in human emotional deception. The presence of upper face surprise in deceptive pleas is likely the result of failed attempts to portray sadness; liars can easily raise their eyebrows (i.e., contract their *frontalis* muscle, the primary muscle involved in the expression of surprise), but it is considerably more difficult to raise only the inner (and not the outer) *frontalis*, as is required for the simulation of grief in the forehead. Further, Darwin (1872) noted that the *corrugator supercilli*, which pulls the eyebrows together to create vertical wrinkles between the eyebrows and often is involved in the distress expression, is difficult to engage voluntarily (and in the absence of genuine emotion). The complementary prong of Darwin's (1872) inhibition hypothesis also was supported in the leakage of lower face happiness on the faces of deceptive pleaders. Possibly as a result of genuine satisfaction relating to the victim's demise or "nervous laughter," the presence of a smirk was a strong predictor of deception in this context. These findings are consistent with Hurley and Frank (2011) who found that liars could not completely

inhibit eyebrow or lip corner movement despite instructions to do so during a mock crime interrogation.

Despite the credence bestowed upon microexpressions as a cue to deception by the scientific and popular media communities, these brief emotional expressions occurred only rarely, even in such highly-motivated and emotional deceptive pleas. Full-face, as well as upper or lower face, expressions lasting 1/25th to 1/5th of a second occurred approximately equally across genuine and deceptive direct appeals. Microexpressions in genuine appeals predominantly signaled sadness, potentially providing a cue to honesty. However, both genuine and deceptive appeals also included rare instances of briefly-expressed happiness, disgust, and fear. In general, it appears that while microexpressions may sometimes signal genuine emotions (i.e., Ekman, 2006; ten Brinke, MacDonald et al., 2011), the rarity with which they occur limits their potential as a cue to deceit. Fortunately for the lie detector, longer-lasting emotional displays appear to be a more reliable signal of deception, and one that may be combined with other behavioural cues to enhance the accuracy of credibility assessment.

The use of fewer words by deceptive pleaders, particularly during the direct appeal, reflects the increased cognitive load experienced by the liar and/or a strategy on the liar's part to provide few details to avoid an inconsistency in the future (Hypothesis 2) (Vrij, Fisher et al., 2008). Again, deceptive pleaders used more tentative words than genuinely distressed individuals, supporting Hypothesis 3. While genuine pleaders were confident and committed to the safe return of their missing loved one (e.g., Pam Poirier desperately pleading for her daughter's return, "…Katie please call us and tell us you're okay. Whoever took our Katie, please tell her we miss her, we love her, and we want her to come home…"; Radli, 1999), deceptive murderers used tentative words to (unconsciously) avoid commitment in their words to

distance themselves from or subtly communicate knowledge of a transgression. For example, wife killer Michael White stated, "*If* whoever has her, *or if* she's out there and you see me, and you see this, just stay there, we'll find you. We will, I'll find you." White tells his (deceased) wife that *if* she sees this message (which he knows she will not) she should stay where she is and he will find her. Interestingly, White indeed led a search party to his wife's body several days later (CTV News, 2006). Thus, while White plays the role of a distressed husband, his statements betray his knowledge of his wife's fate.

Lastly, speculation about the efficacy of body language cues was partially supported (Hypothesis 4). While the use of illustrators and self-manipulators was rare, deceptive pleaders were able to maintain appropriate levels of eye contact. However, differential blink rate across pleader veracity approached significance; on average, deceptive pleaders blinked nearly twice as quickly as genuinely distressed individuals. This parallels experimental findings by Porter and ten Brinke (2008) who found that the arousal associated with masking emotion was associated with increased blink rate, and opposes the notion that cognitive load, alone, can account for changes in blink rate during deception (Leal & Vrij, 2010).

Theories of cognitive load, emotional falsification, and psychological distancing all uniquely contributed to explaining behavioural differences between genuinely distressed pleaders versus deceptive killers, supporting the proposition that reliance on a combination of behavioural channels is more effective than any single indicator (Hypothesis 5) (Porter & ten Brinke, 2011). Word count, tentative word use, and emotional cues (unsuccessful attempt to appear sad, leakage of happiness) each accounted for unique variance between genuine and deceptive pleaders. While this model correctly classified credibility in 90% of cases, with a minimal false positive rate, further research is necessary to determine the predictive validity of

these cues among different (and larger) samples, and to determine whether these cues indicate deception in other high-stakes contexts (see also Ekman et al., 1991). For example, instances in which suspects deny knowledge of their transgression may also include a decreased number of words and leakage of happiness related to their actions. However, failed attempts to appear distressed are unlikely to be relevant in this situation. In general, future research should examine behavioural consequences of deception in a variety of high-stakes settings, with a focus on uncontrollable (facial, linguistic) leakage.

2.4.3 Implications.

A consideration of the indicators examined here and the relative importance of each may serve as a guide for directing missing person or murder investigations where there is reason to suspect a family member of foul play. Further, training legal and security staff to spot these, and other empirically-supported, signals of covert, high-stakes information are likely to lead to increasingly accurate decision-making in contexts where lies can have life and death consequences. Recently, a group of psychologists were trained in the pitfalls and promises of deception detection. Specifically, the present findings were discussed at length and, using videos of the pleaders studied here, baseline and post-training deception detection accuracy was tested. The full-day training workshop led to dramatic post-training gains (46.4% vs. 80.9%) associated with both an increased hit rate and decreased false alarm rate (Shaw et al., 2011). More generally, these findings begin to illuminate those behavioural cues that are prone to successful impression management (i.e., body language) and those that have the potential to indicate deception in highly motivated deceivers. These findings offer an important and novel advancement of our understanding of involuntary human communication.

Table 2.1

Sample Characteristics

	Complete Pleas		Direct Appeal	
	Genuine	Deceptive	Genuine	Deceptive
	n = 43	*n* = 35	*n* = 26	*n* = 26
Gender of Pleader				
Male	22	26	13	18
Female	21	9	13	8
Relationship to Missing/Murdered Person				
Parent-Child	35	18	21	13
Spouse/Partner	1	20	0	14
Sibling	3	1	2	1
Grandparent-Grandchild	3	0	2	0
Other	6	5	2	3

Note. Relationship totals exceed sample size due to several cases of multiple homicide.
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Table 2.2

Frequency of Case Evidence Used to Establish Ground Truth

	Genuine *n* = 43	Deceptive *n* = 35
Evidence type		
Victim's Blood	10	10
DNA (hair, skin, etc.)	3	10
Forensic evidence (pollen traces, tire tracks, etc.)	15	25
Possession of murder weapon	2	1
Security camera footage	7	10
Phone range or tap information	7	5
Confession (not recanted)	13	14
Led police to victim's body	5	7
Incriminating monetary transactions	5	1
Inadequate alibi	11	3
Eyewitness testimony	5	1

Note. Totals exceed sample size since majority of cases were classified based on several pieces of evidence. Reprinted with permission of *Law and Human Behavior.*

Table 2.3

Descriptive Statistics for Each Cue During the Direct Appeal

	Mean (*SD*) of Continuous Variables		Events per Variable (Frequency of Presence)	
Cue	Genuine *n* = 26	Deceptive *n* = 26	Genuine *n* = 26	Deceptive *n* = 26
Verbal				
Word Count	47.77 (39.52)	22.47 (14.73)	26	26
Speech Rate (/min)	147.68 (55.62)	141.50 (49.25)	26	26
Speech Hesitations (%)	1.34 (2.32)	1.07 (2.64)	8	5
Pronouns (%)	16.13 (8.72)	17.48 (7.76)	24	24
Tentative Words (%)	5.24 (6.13)	13.94 (9.50)	19	23
Positive Emotion (%)	.74 (1.57)	1.69 (3.71)	6	7
Negative Emotion (%)	1.41 (2.70)	.47 (1.73)	10	3
Body Language				
Illustrators (/min) †	.58 (2.50)	.05 (.28)	3	1
Face-Manipulators (/min) †	.57 (1.95)	1.54 (5.49)	2	2
Blink (/min)	29.81 (22.45)	41.62 (31.62)	26	24
Gaze Aversion (%)	13.76 (27.01)	27.82 (35.18)	12	15
Emotion (Presence)				
Upper Face				
Happiness†			0	3
Sadness			11	6
Anger			11	6

	Mean (*SD*) of Continuous Variables		Events per Variable (Frequency of Presence)	
Cue	Genuine *n* = 26	Deceptive *n* = 26	Genuine *n* = 26	Deceptive *n* = 26
Contempt†			0	0
Surprise			5	15
Lower Face				
Happiness			6	13
Sadness			10	4
Fear			6	6
Anger			7	6
Disgust			3	8
Contempt†			0	1
Surprise†			1	1
Microexpressions				
Upper Face†[a]			3	2
Lower Face†[b]			5	4
Full Face†[c]			2	0

† Variables rarely present and excluded from further analysis (e.g., Hosmer & Lemeshow, 2000).
[a] Upper face microexpressions by the three genuine pleaders included two expressions of anger and one surprise. The two deceptive pleaders who revealed upper face microexpressions both expressed sadness.
[b] Lower face microexpressions revealed by five genuine pleaders included five expressions of sadness, two happiness, and one disgust. Of the four deceptive pleaders leaking microexpressions, two revealed happiness, one disgust, and the other fear.
[c] Full-face microexpressions occurred only in genuine pleas; two genuine pleaders revealed a total of five brief flashes of sadness.

Table 2.4

Logistic Regression Analysis of Veracity as a Function of Selected Verbal and Emotional Variables During the Direct Appeal

Predictors	β	Bootstrap 95% CI[1]		Wald χ^2	Odds
		Lower	Upper		Ratio
Upper Face Surprise	2.52	.76	18.86	6.90*	12.49
Lower Face Happiness	1.56	-.25	10.16	3.31†	4.76
Tentative Words	.14	.05	.81	6.13*	1.15
Word Count	-.04	-.32	-.01	4.37*	.96

† $p = .06$; * $p \leq .05$

[1]Bootstrapping was used to estimate 95% confidence intervals for each regression coefficient (Efron, 1979). In this method, random sampling with replacement was used to create $n = 1000$ samples of the original size. The distribution of the regression coefficients across each of these resamples created an empirically-derived sampling distribution to calculate 95% confidence intervals that assess the stability of parameters across alternate samples (Rodgers, 1999). Reprinted with permission of *Law and Human Behavior.*

3. Chapter Three. Darwin the Detective

3.1 Synopsis

Among his basic assertions, Darwin (1872) argued that emotional expressions, once consciously controlled, became habitual, and subsequently, inherited, involuntary manifestations of one's inner state. Further, of all those communication channels through which emotional signals may be expressed, Darwin considered the face to be "chief." He posited that facial expressions are adaptive for the bearer of an emotion, allowing him/her to better process or respond to (and survive) the emotion-inducing situation at hand. For example, Darwin observed that the expression of anger narrowed visual focus on the object provoking the affective state and revealed the canine teeth to signal and prepare for a physical attack. Recent research by Susskind and Anderson (2008) found that characteristics of fear and disgust expressions provide a functional advantage in sensory experience to the bearer of the emotion. Subjects expressing fear reported a larger visual field and engaged in faster eye movements during target localization, potentially allowing them to identify the source of their fear and plan an escape more effectively. Further, facial expressions of fear allowed for increased air intake, potentially providing the fearful individual with the oxygen necessary to engage in a fight or flight response. In contrast, the narrowed eyes and scrunched nose of disgust decreased visual field, visual scanning speed and air intake, reducing the sensory information associated with the potentially noxious stimulus. Similarly, sensory acquisition expansion or narrowing advantages have been proposed for expressions of surprise and anger, respectively (Susskind & Anderson, 2008).

The functional advantages of these expressions, enjoyed by the bearer, have been co-opted by social companions; these expressions also *signal* emotions that can be interpreted by the observer to aid social communication (Schmidt & Cohn, 2001; Susskind & Anderson, 2008).

Humans evolved not only to express emotions in particular, functional ways but also to recognize the meaning of these expressions in others (a cross-cultural finding established by Ekman et al., 1969). An observer often can quickly assess the emotions and intentions communicated by the face of another person, allowing him/her to infer the best course of action (Ekman et al., 1987; Williams & Mattingley, 2006). Confronted by an individual with glaring eyes, dilated nostrils and barred teeth, one quickly determines that he/she is enraged, prompting avoidance (even fleeing!) behaviour and maximizing one's chance of survival (Oosterhof & Todorov, 2008). In contrast, recognizing a smile could promote social or even sexual interaction (e.g., Jones et al., 2006).

3.1.1 The evolution of the deceptive face.

The salient expression of one's innermost emotions on the face, however, is not always optimal from the perspective of the bearer of the emotion, and sometimes not from the observer's perspective either. On average, people lie twice per day (e.g., DePaulo et al., 1996); some common motives include altruism (people often lie for the benefit of others or to facilitate social cohesion; Vrij, 2008a), impression management (for example, to impress on a first date), or for the direct personal advantage of the liar (lying in order to take advantage of someone financially or sexually; Seto, Khattar, Lalumiere, & Quinsey, 1997). It appears that lying is deeply embedded in human nature as a result of evolution, and is witnessed in numerous other species including our primate cousins – chimpanzees and gorillas (see Bond & Robinson, 1988). There are numerous ways through which the use of interpersonal deception would have conferred evolutionary advantages to humans; one example is the finding that men deceive in ways that correspond with female mate selection criteria (deceiving with regard to resources, status, commitment, and trustworthiness increasing their mating opportunities) and to raise their

perceived dominance among other males (e.g., Buss, 2003; Haselton, Buss, Oubaid, & Angleitner, 2005). Further, the tendency to deceive appears to have genetic correlates and thus, can be passed on to future generations to further promote survival and reproduction (e.g., Rowe, 1986).

It is our contention that humans evolved to express emotion, to recognize emotion in others, and to deceive others about their emotions in functional ways. However, it appears that humans did not evolve to effectively recognize deceptive communication by others. Most deception is successful; in numerous studies, observers have been found to perform at the level of chance in deciding if another person is being truthful (e.g., Bond & DePaulo, 2006; Ekman & O'Sullivan, 1991) or whether a particular facial expression is genuine or false (e.g., Porter & ten Brinke, 2008; Porter, ten Brinke, Baker, & Wallace, 2011). This could result from (a) an absence of behavioural signals to deception or (b) an inability – perceptual and/or knowledge-based – to identify existing behavioural signals to deception. We suggest that both may play a role, depending on the nature of the interpersonal deception. For everyday, low-stakes white lies of little consequence, there are probably no or few behavioural signs (e.g., Hartwig & Bond, 2011). However, lies of consequence generally are more difficult to tell than other lies and should be accompanied by more salient behavioural signals (DePaulo et al., 1988). Lying about infidelity or one's knowledge of a committed or planned transgression or crime can be a complex undertaking and enormously stressful for most people. Telling such lies requires the deceiver to concurrently keep the details of his/her lines straight and appear 'credible' to a potentially apprehensive observer. And such lies often are accompanied by powerful emotions – fear, remorse, anger, or even excitement – that must be inhibited and/or convincingly faked (Porter & ten Brinke, 2010). Consider the concerned mother, pleading for assistance in finding her missing child when in fact the child has been murdered by her hand. In such instances, the deceiver is

highly motivated to express emotional signals on her face that are consistent with her fabricated story, and suppress genuine expressions that may be discordant with the story. This powerful motivation to look credible, coupled with the complexity of creating and maintaining a consequential lie, paradoxically may lead to greater leakage of deception signals and greater likelihood of detection (DePaulo et al., 1988; O'Sullivan et al., 2009).[1]

3.1.2 The inhibition hypothesis.

Our contention that human deception of consequence will be accompanied by emotional "leakage" was foreshadowed by Darwin's (1872) observations on the involuntary nature of facial expressions. He suggested that some facial muscle actions associated with emotion cannot be completely inhibited despite efforts by the emotion bearer and that attempts to contract certain facial muscles during emotional simulation will fail. Collectively, these propositions form the *inhibition hypothesis*; a proposal that has not – until recently – received direct empirical attention (Ekman, 2003a).

In a preliminary examination of the inhibition hypothesis, Porter and ten Brinke (2008) examined the nature of facial expressions accompanying falsified or concealed happiness, sadness, fear, and disgust. Participants viewed powerful emotional images, responding with a genuine or convincing but false expression. Frame-by-frame coding of nearly 700 videotaped expressions revealed that no participant was able to simulate an unfelt emotional expression on all trials without the presence of emotional leakage on at least one occasion (although most were sometimes successful deceivers). Leaked expressions were rarely expressed across the entire

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[1] Trivers (2000) argued that the liar may reduce the likelihood of detection by means of self deception or mis-believing their deceptive tale. This phenomenon may be selected in successive generations for its advantage in successfully deceiving and manipulating others (McKay & Dennett, 2009; von Hippel & Trivers, 2011).

face, instead appearing in the upper or lower face only (e.g., a smirk when attempting to appear sad), often lasted up to a second in duration, and were more likely to occur during false expressions of negative emotions, relative to falsified happiness. A recent follow-up study found that one's true emotion is particularly difficult to suppress – and more likely to be revealed on the face – when it is strong, relative to weaker emotional states (Porter, ten Brinke, & Wallace, 2012).

Further supporting the importance of the face in unmasking liars, Ekman et al. (1988) found that nurses motivated to mask feelings of disgust could not successfully replace this expression with a genuine smile, instead displaying 'masking smiles,' involving only the lower, not the upper, face. Facial analysis of deceptive mock crime interrogations and personal opinion statements include leakage of fear and disgust (Frank & Ekman, 1997). Further, Hurley and Frank (2011) recently reported that eyebrow raises and (to a lesser extent) smiles often are leaked despite attempts to suppress this movement. Previous studies also have found differences in the duration, onset, and offset times between genuine and false emotional expressions (Frank, Ekman, & Friesen, 1993; Hess & Kleck, 1990).

This previous research examined relatively low-stakes deception (although even within this body of work it was demonstrated that stronger emotion was more likely to result in facial leakage; Porter, ten Brinke, & Wallace, 2012). Facial indicators of deceit – leakage of genuine emotion and failed attempts to portray false affect – are likely to be particularly salient in high-stakes, emotional situations. When faced with the difficult task of masking intense genuine emotions, while simultaneously telling (and remembering) details of a plausible story, managing body language, and considering the consequences of failure, the deceiver's facial muscles are likely to betray his/her deception. We propose a constraint argument to further articulate

Darwin's (1872) inhibition hypothesis. Given limited cognitive resources and the difficulty of necessary multi-tasking during deception, we suggest that emotional leakage is particularly likely to occur when the lie is complex and/or associated with strong emotions to be concealed or falsified. Specifically, we expect those facial muscles least under cognitive control will be most likely to fail.

Volitional facial movements (i.e., deceptive emotional expressions) utilize different neutral pathways than genuine expressions induced by felt emotion (Rinn, 1984). Although they share the same motoneurons and premotor interneurons, volitional movement impulses emanate from the cortical motor strip, while genuine emotional impulses originate from the ancestral, extrapyramidal motor system. Evolution of the human cerebral cortex, however, did not replace the ancestral system and thus, emotional expressions only can be approximated or partially suppressed by cortical commands. Clinical evidence for this distinction comes from studies of brain lesion patients; damage to the motor cortex may impair voluntary facial movements, but genuine emotional expressions can still be accurately communicated (Holstege, Mouton, & Gerrits, 2004). And, on the other hand, patients with damage to nuclei of the extrapyramidal motor system (e.g., the basal ganglia) retain the ability to move facial muscles upon voluntary command, but do not express spontaneous emotional movements (Rinn, 1984).

In general, muscles of the lower face are contralaterally innervated, and under fine voluntary control. This allows for complex tasks such as talking and chewing (Rinn, 1984). As one ascends the face, however, muscles increasingly become innervated by the ipsilateral motor cortex and fine movements are less under volitional control. Thus, it is the upper facial muscles that are expected to fail first during emotional deception (Hurley & Frank, 2011). And research supports the notion that upper facial movements are both more difficult to falsify and suppress

than lower facial movements (e.g., Ekman, Friesen, & O'Sullivan, 1988; Hurley & Frank, 2011; Porter, ten Brinke, & Wallace, 2012). In summary, it is proposed that emotional leakage is a byproduct of the cognitive load associated with complex, highly emotional lies, coupled with the characteristics of human facial muscle innervation.

3.1.3 High-stakes emotional deception.

In the first study to examine facial cues to deceit during real-life, high-stakes, emotional deception (presented in Chapter 2), we examined the videotaped behaviours of a large international sample of individuals emotionally pleading to the public for the return of a missing relative, half of whom were later determined to have murdered the relative prior to the public appeal (ten Brinke & Porter, 2011). During the critical lie, told by each deceptive murderer, upper face surprise and lower face happiness were likely to be expressed, attributed to the failed attempt to appear sad and leakage of happiness. Although we speculate that the presence of upper face surprise in deceptive pleas is due to failure of the *frontalis* and *corrugator supercilli* muscles in the attempted expression of sadness, the gross emotional coding, based on variants of prototypical emotional expressions (Ekman et al., 2002), utilized in Chapter 2 preclude any definite conclusions. Thus, the identification of the facial muscles that Darwin (1872) identified as "least obedient to the will" in this context remains to be empirically investigated.

Darwin (1872) noted that contraction of the *depressor anguli oris* muscles, turning the lip corners downward, is an innate manifestation of genuine grief. Further, he observed that few people can voluntarily activate grief muscles in the forehead (*corrugator supercilli*, *depressor supercilli* and *procerus*), except the *frontalis* which is easily contracted to raise the eyebrows (Ekman, 1992, 2003b). Regarding the leakage of happiness or potential "duping delight," empirical work has confirmed that genuine happiness involves contraction of this muscle, as well

as the *orbicularis oculi*, creating crows' feet around the eyes (Ekman et al., 1990; Ekman et al., 1988). However, *zygomatic major* activity without corresponding contraction around the eyes may be a voluntary, masked smile. This action is hypothesized by Ekman (2003b) to conceal other emotional leakage rather than indicate genuine enjoyment.

3.1.4 The current study.

The current study investigated for the first time the facial muscles that are least amenable to volitional control during high-stakes emotional deceit. Actions of the *frontalis, corrugator supercilli, orbicularis oculi, zygomatic major*, and *depressor anguli oris* were examined in televised appeals for the safe return of a missing relative, a novel paradigm in the study of high-stakes deception. It was expected that genuinely distressed pleaders would be more likely to engage muscles innately associated with sadness, relative to deceptive individuals: *corrugator supercilli* (Hypothesis 1) and *depressor anguli oris* (Hypothesis 2). In contrast, direct appeals by deceptive murderers were expected to fail in their representation of voluntary aspects of sadness in the upper face (gross activation of the *frontalis*, of which only the medial *frontalis* is relevant to grief) (Hypothesis 3) and produce voluntary, masking smiles (*zygomatic major* in the absence of *orbicularis oculi* activation) (Hypothesis 4).

3.2 Method

3.2.1 Cases.

Videos of 52 (26 deceptive) individuals who made televised pleas for the safe return (or information leading to an arrest in the murder) of their relative were gathered from news agencies in Australia, Canada, the United Kingdom, and the United States. Deceptive individuals were eventually convicted based on overwhelming physical evidence (e.g., DNA). In cases of

genuine pleaders, someone else had been convicted based on similarly overwhelming evidence or the missing person was later located in the absence of foul play (see Chapter 2 for additional details regarding the determination of ground truth). The deceptive pleader was most commonly a man (18 men, 8 women) and the spouse/romantic partner of the victim. In contrast, genuine pleaders included 12 men and 14 women and most commonly were parents, seeking the safe return of their missing child (refer to Table 3.1 for additional sample characteristics).

3.2.2 Coding procedure.

Of particular interest in the current investigation was the portion of video during which the individual made a direct appeal to the (supposed) perpetrator to release the missing person, to the missing person to make contact, or to the public for information/search party assistance. A (blind to condition and hypotheses) coder identified this portion of each video by reading transcripts of each plea, identifying relevant speech and providing start/stop time codes for this portion of each plea. This portion of each plea was comprehensively coded (by a trained coder, blind to veracity and hypotheses) for the presence and duration of selected facial action units, the smallest units of independent facial movement (Ekman et al., 2002).

Training in this coding method involves intensive study and practice with the Facial Action Coding System (FACS; Ekman et al., 2002). Action units of interest to the present study were related to activation of the *frontalis, corrugator supercilli, orbicularis oculi, zygomatic major*, and *depressor anguli oris* (AUs 1, 2, 4, 6, 12, 15; Waller, Cray, & Burrows, 2008). AUs 1 and 2 map onto the forehead's *frontalis* muscle. In combination, they raise the eyebrows, as in surprise. In isolation, AU1 raises only the inner eyebrows and AU2, the outer eyebrows. AU4 (brow lowerer) involves activation of the *corrugator supercilli* (as well as co-activated *depressor supercilli* and *procerus*). AU6 is an important element of genuine happiness and involves

activation of the *orbicularius oculi*, raising the cheek, compressing the eyelid and sometimes creating crow's feet in the eye corners. Activation of the *zygomatic major* is represented by AU12, pulling the lip corners back and upward as in a smile. Lastly, AU15 (*depressor anguli oris*) depresses the lip corners, pulling them downward, as in sadness.

Coders studied the entire manual, but paid specific attention to AUs 1, 2, 4, 6, 12, and 15. Coders studied these action units in detail and completed image and video examples provided in the FACS manual, achieving at least 90% accuracy in these exercises. Ekman noted that expertise in coding every action unit is often unnecessary when specific muscles are of interest, and that self-training with his materials can produce reliable coders (Ekman & Oster, 1979; Ekman et al., 2002). Coding involved classifying the onset and offset times of each action unit by examining facial muscle activation in every 1/30th-second frame of video.[2] In order to avoid overwhelming the coder, and to reduce errors, upper face action units (AUs 1, 2, 4, 6) were coded separately from lower face action units (AUs 12, 15). Thus, a grand total of 23,622 frames across all 52 pleaders were coded twice: once for the presence of selected action units in the upper, and again in the lower, face for a total of 47,244 codes.

3.2.3 Coding reliability.

A second trained coder completed action unit coding of 13 (25.0%) videos, to assess inter-rater reliability. The dichotomously-coded presence (or absence) of each action unit was reliable (Kappa = .57-.71, $p < .05$, 78.6 - 85.7% agreement; Krippendorff, 1980; Reitveld & van Hout, 1993). Further, coders agreed on the duration of each action unit. Duration scores were highly correlated (rs = .66 - .98, $p < .05$) and means did not differ (ps > .05) across coders.

[2] Due to varying quality of acquired video footage, coding of AU intensity – a more detailed and nuanced variable than presence/duration – was not conducted.

3.3 Results

On average, direct appeals lasted 454.27 (*SD* = 427.95) frames. Genuine (*M* = 593.42; *SD* = 515.56) pleas were significantly longer than deceptive pleas (*M* = 315.12; *SD* = 259.84), $t(50) = 2.46$, $p < .05$, partial $\eta^2 = .11$. As such, durations of AUs 4, 15, 1+2, 12, and 6+12 were examined as proportions (i.e., AU duration/total direct appeal duration) to control for any effect of differential plea duration across groups.

3.3.1 Proportion of action unit activation.

A MANOVA with veracity (genuine vs. deceptive) as the between-subjects factor was conducted with the proportion of AUs 4, 15, 1+2, 12, and 6+12 duration as dependent variables. A significant multivariate effect of veracity was revealed, $F(5, 46) = 3.90$, $p < .05$, $\eta^2 = .30$. Follow-up univariate analyses on each of the five dependent variables revealed that genuine pleaders activated their *corrugator supercilli* muscles (AU4) for a greater proportion of their plea than deceptive murderers, $F(1, 50) = 3.90$, $p = .05$, $\eta^2 = .07$ (Hypothesis 1). Genuine pleaders (*M* = .28, *SD* = .28) also engaged their *depressor anguli oris* (AU15) muscles longer than deceptive individuals (*M* = .18, *SD* = .25); however, this difference was not statistically significant, $F(1, 50) = 2.08$, $p = .16$, $\eta^2 = .04$ (Hypothesis 2). Supporting Hypothesis 3, deceptive pleaders (*M* = .19, *SD* = .29) exhibited a greater proportion of *frontalis* (AU1+2) activation than genuine pleaders (*M* = .02, *SD* = .05), $F(1, 50) = 9.13$, $p = .01$, $\eta^2 = .15$. Deceptive individuals (*M* = .12, *SD* = .17) also smiled more, exhibiting a greater proportion of AU12 than genuine individuals (*M* = .01, *SD* = .04), $F(1, 50) = 9.80$, $p = .01$, $\eta^2 = .16$. Further supporting Hypothesis 4, this difference appears to be limited to masking smiles as no difference in genuine smile (AU6+12) duration was found between truth-tellers (*M* = .00, *SD* = .01) and liars (*M* = .01, *SD* = .04), $p > .05$.

3.3.2 Presence of action units.

A series of five logistic regression analyses was conducted to examine differences in the presence/absence of AUs 1+2, 4, 6+12, 12, and 15 across plea veracities. Refer to Table 3.2 for regression coefficients, 95% confidence intervals, Wald χ^2 statistics, and odds ratios. The presence of AU15 (*depressor anguli oris)*, being more common in genuine (present in 22 of 26) than deceptive pleas (present in 13 of 26), significantly predicted veracity, $\chi^2(1, N = 52) = 7.68$, $p < .01$, provided support for Hypothesis 2, and classified the veracity of 67.3% of pleaders correctly (84.6% genuine; 50.0% deceptive). Failure to replicate correct activation of the *frontalis* (AU1+2) was significantly more likely to occur in deceptive (present in 14 of 26) than genuine (present in 4 of 26) direct appeals, $\chi^2(1, N = 52) = 5.13$, $p < .01$ (Hypothesis 3). Presence (or absence) of full *frontalis* activation correctly classified 53.8% of deceivers and 84.6% of truth-tellers (69.2% overall). Lastly and in support of Hypothesis 4, masking smiles (AU12) were significantly more likely to occur in deceptive (15 of 26) than genuine (5 of 26) appeals, $\chi^2(1, N = 52) = 7.52$, $p < .01$. Masking smiles correctly classified 57.7% of deceivers and 80.8% of truth-tellers (69.2% overall).

3.4 Remarks

The expression of emotion often is consciously manipulated to facilitate deception and can have major consequences when undetected (Porter & ten Brinke, 2010). As he addressed his country (and the world), Bill Clinton wore an angry visage while vehemently denying having sexual relations with Monica Lewinsky. Bernie Madoff pulled off the largest fraud in history, successfully deceiving his investors for years (Creswell & Thomas, 2009). And Susan Smith pleaded for the return of her two young boys, garnering the support of an entire nation after intentionally drowning her children in her car and staging it as a car-jacking (Gibbs, Booth,

Gregory, Munroe, & Towle, 1994). Despite the fact that emotional deception sometimes is successful, behavioural cues can unmask the false face in cognitively demanding situations (Porter, ten Brinke, & Wallace, 2012; ten Brinke & Porter, 2011). The present study expanded on that presented in Chapter 2 and investigated, for the first time, the action of specific facial muscles speculated to reveal falsified sadness, on the faces of individuals deceptively pleading for the return of a missing relative who they had recently murdered.

Darwin's (1872) inhibition hypothesis, paired with our current understanding of facial innervation and cognitive constraints, appears to be a concise summary of deceptive facial behaviour in this context. The failed attempt to portray falsified emotions was found to reveal duplicity in this context. Regarding the "grief muscles" in the forehead, Darwin (1872) observed that they were difficult to intentionally activate. Rinn (1984) suggested that the nature of facial muscle innervation explains this phenomenon; muscles of the upper face are under less cortical control and do not allow for fine motor control, unlike lower facial muscles. Supporting this notion, gross movements of the *frontalis* muscle, acting to raise the inner and outer eyebrows, easily are engaged voluntarily (Ekman, 2003b). However, most people are unable to raise the inner eyebrow (AU1; medial *frontalis*) without also engaging the outer eyebrow raise (AU2; outer *frontalis*), resulting in an expression that approximates surprise better than the intended sadness/distress expression (Ekman et al., 2002; ten Brinke & Porter, 2011). Indeed, when deceptive murderers attempted to replicate the upper facial movements of sadness, their *frontalis* activation was more often gross, raising the entire eyebrow, rather than just the inner *frontalis* as would be expected in a genuine expression of this emotion (ten Brinke & Porter, 2011) (Hypothesis 2). Thus, supporting Darwin's (1872) original observations, the voluntary facial muscles are likely to fail when under the strain imposed by high-stakes deception.

Deceptive pleaders also were more likely to show activation of the *zygomatic major* (AU12) than genuinely distressed pleaders. While it is conceivable that the deceptive pleader may be harbouring some genuine happiness at their victim's demise or experiencing some duping delight, the activation of this muscle in the absence of the *orbicularis oculi* (AU6) suggests that the deceiver is not revealing some source of genuine enjoyment, but rather is utilizing this muscle to mask some other emotional leakage (Ekman et al., 1988). Indeed, such masking smiles may be used to conceal genuine disgust revealed in Chapter 2 (ten Brinke & Porter, 2011) or a host of other possible emotions experienced by the deceptive pleader (Hypothesis 4). Regardless of the source, the leakage of *zygomatic major* activation, as speculated by Ekman (2003b), is a strong predictor of pleader insincerity.

In contrast with deceptive killers, genuine pleaders more often displayed activation of each of those innate grief muscles that are associated with sadness cross-culturally and are hypothesized to have served some functional benefit to the bearer (Darwin, 1872; Matsumoto & Willingham, 2009). Individuals genuinely and desperately seeking the safe return of a loved one displayed AU4, associated with contraction of the *corrugator supercilli*, for a greater proportion of their pleas, relative to deceptive pleaders (Hypothesis 1). The flip side of this finding reveals that deceptive pleaders were unable to maintain activation of this upper face muscle, presumably due to its reduced cortical connectivity and various other challenges faced by the deceiver limiting their cognitive control over this contraction. The *depressor anguli oris* (AU15) also was engaged more often by genuine, compared to deceptive, pleaders who were engaged in diametrically opposed 'masking smiles' (Hypothesis 2). In sum, the presence of innate facial actions related to sadness was a reliable indicator of genuine feelings of distress and sincerity in emotional pleas to the public.

Although the use of frame-by-frame FACS (Ekman et al., 2002) is impractical in most real-world contexts, research suggests that some individuals may be naturally able to detect subtle emotions that signal detection and that training to do so can dramatically improve deception detection abilities. Warren et al. (2009) found that performance on a subtle emotional expression detection task was correlated with ability to detect emotional lies. And evidence suggests that if one is not naturally gifted with such emotional insight, emotional deception detection can be, to an extent, learned (Shaw et al., 2011).

While serving as convincing support for attention to the face in credibility assessment, limitations of facial analysis should be acknowledged. Given that the face does not reveal the source of its expression, ephemeral contractions of the *frontalis* (AU1+2) by genuine pleaders may not reveal falsified sadness, but rather serve as speech emblems meant to emphasize the importance of their spoken message (Ekman, 2009). Attention to the duration of these facial actions may clarify potential misinterpretation of this expression; deceptive pleaders hold this failed attempt to appear distressed for a greater proportion of their appeal than genuine individuals who may only briefly raise their eyebrows for emphasis. Further, genuine pleaders may engage the *zygomatic major* (AU12) in a voluntary smile meant to reassure the missing person that they will be soon rescued or that he/she is welcome to return home. Alternatively, the absence of these cues does not necessarily absolve the pleader of involvement in the missing person's disappearance; psychopathic individuals are unlikely to "leak" genuine emotions and highly emotional intelligent people often are successful simulators of emotion (Porter, ten Brinke, Baker, & Wallace, 2011). Thus, while the face does not represent a "silver bullet" in the lie detector's arsenal, facial action analysis, combined with indices of cognitive load, impression management, and psychological distancing can result in highly accurate predictions of an individual's credibility (Ekman et al., 1991; ten Brinke & Porter, 2011; Vrij, 2008a).

This research utilized a novel paradigm to address the scarcity of research investigating high-stakes, real-world deceit, finding support for facial analysis in this context and a by-product perspective of emotional leakage under cognitive load more generally (Porter & ten Brinke, 2010). Specifically, this work supports the astute observations of Duchenne (1862), Darwin (1872), and Ekman (2003b) who noted that emotional facial actions might reveal a false face despite a deceiver's best attempts to conceal his/her affective state. Indeed, these findings support the notion that the human face is indelibly stamped with the tale of our humble origin and attempts to mask our emotions are likely to fail when engaging in a consequential act of deception.

Table 3.1

Sample Characteristics

	Genuine *n* = 26	Deceptive *n* = 26
Gender of Pleader		
Male	13	18
Female	13	8
Relationship to Missing/Murdered Person		
Parent-Child	21	13
Spouse/Partner	0	14
Sibling	2	1
Grandparent-Grandchild	2	0
Other	2	3

Note. Relationship totals exceed sample size due to several cases of multiple homicide. Reprinted with permission of *Evolution and Human Behavior*.

Table 3.2

Logistic Regression Inferential Statistics for Each Relevant Action Unit (or Combination)

Predictors	β	Bootstrap 95% CI[1] for β		Wald χ^2	Odds Ratio
		Lower	Upper		
AU 4	-1.00	-2.42	.14	2.85†	.37
AU 15	-1.71	-3.59	-.47	6.47**	.18
AU 1+2	1.86	.60	4.00	7.68**	6.42
AU 12	1.75	.58	3.5	7.52**	5.73
AU 6+12	1.05	-.82	21.63	1.40	2.86

† $p < .10$, * $p < .05$, ** $p < .01$ (Bonferroni correction)

[1]Bootstrapping was used to estimate 95% confidence intervals for each regression coefficient (Efron, 1979). In this method, random sampling with replacement was used to create $n = 1000$ samples of the original size. The distribution of the regression coefficients across each of these resamples created an empirically-derived sampling distribution to calculate 95% confidence intervals that assess the stability of parameters across alternate samples (Rodgers, 1999). Reprinted with permission of *Evolution and Human Behavior.*

4. Chapter Four. Conclusion

It was snowing in the sleepy Nova Scotia town of Bridgewater the evening that 12-year-old Karissa Boudreau disappeared. It was reported that she had run away, out of the family vehicle, as her mother shopped at the local grocery store. Reported missing on January 27, 2008, the community at large feared the worst as time passed and temperatures dropped. Karissa's mother, Penny, made a tearful appeal to her daughter; police attention was tuned to Penny's boyfriend, Vernon Maccumber, who sat by the distressed mother's side. His face – a confused and blank stare – showed no signs that he knew Karissa would be found, murdered, days later. To test the emerging research hypothesis that the face could unmask the deceptive murderer in this context, the author examined, in detail, Penny's behavioural presentation during her plea to the public. Failed attempts to appear sad, leakage of happiness, and peculiar aspects of her verbal (i.e., minimization) and body language (i.e., use of facial manipulators) behaviour suggested that she held covert knowledge of her daughter's demise. Indeed, Penny later confessed to strangling the 12-year-old and staging it as a sexually motivated crime by pulling down her own daughter's pants after she was confronted with incriminating wire-tap evidence, making her the first murderer Bridgewater had seen in over a decade. Penny currently is serving a life sentence (CBC News, 2009).

Darwin, too, might have seen through the elaborate façade created by Penny Boudreau and other murderous, deceptive pleaders. His inhibition hypothesis suggests that uncontrollable facial muscles can reveal the false face by "leaking" genuine emotion and being notably absent in simulated expressions (Darwin, 1872; Ekman, 2003a). As such, we expected deceptive appeals to involve incomplete, insincere attempts to portray sadness and leakage of discordant emotions (i.e., happiness). During cognitively and emotionally demanding deception, those

facial muscles least under cortical control are likely to fail (Darwin, 1872; ten Brinke, Porter, & Baker, 2011). Specifically, the nature of human facial innervation suggests that muscles in the upper face will be most likely to fail during high-stakes emotional deceit (Rinn, 1984). In contrast, genuine pleas were expected to be dominated by genuine expressions of distress, originating in the brain's emotional, extra-pyramidal motor system. Specifically, Darwin (1872) noted the involuntary nature of the *corrugator supercilli* and *depressor anguli oris* involved in the expression of grief; it was expected that these muscles, in particular, would reveal the false face. Further, increased emotional arousal associated with affective masking was expected to result in an increased blink rate exhibited by deceptive, relative to genuine, pleaders (Porter & ten Brinke, 2008).

Facial indices of deception were expected to be complemented by leakage in the verbal and body language communication channels. Decreased word count, increased speech rate, and hesitations were expected to reveal increased cognitive load associated with such consequential deception. Linguistic choices (e.g., decreased use of emotional words, pronouns, and an increase in tentative words) were hypothesized to indicate non-conscious psychological distancing. Behavioural differences in these relatively less controllable domains were expected to be better indicators of deceit than body language behaviours (e.g., illustrator use), which vary in usefulness as a cue to deceit across situation and personalities (Porter & ten Brinke, 2010). Finally, it was expected that a combination of behavioural cues could discriminate liars from truth-tellers by explaining variance related to emotional arousal, cognitive load and psychological distancing theories of deceptive behaviour.

4.1 Consequences of Emotional Arousal in Pleaders

4.1.1 Facial behaviour across complete plea.

Complete pleas often included varied content such as information about the missing person (i.e., what he or she was wearing at the time of the disappearance), a description of their emotional reaction to the ordeal, a direct appeal to the abductor, missing person, or public, and words of thanks to the investigators or search party members. Further, complete pleas were subject to editing by the broadcasting company from which they were obtained. Despite the uncontrolled nature of the pleas, frame-by-frame coding of pleaders' emotional expressions strongly supported the hypotheses. Specifically, Darwin's (1872) inhibition hypothesis led us to expect that deceptive pleaders would fail in their representation of false sadness and leak their true affective state via muscles that are "least amenable to the will." In support of this notion, complete pleas were associated with the leakage of lower face disgust by deceptive murderers, playing the part of a distressed relative. Indeed, the leakage of genuine disgust via an upper lip raise was hypothesized by Ekman and Friesen (2003). Potentially confirming the emotional leakage prong of Darwin's (1872) astute observation, the expression of disgust in this context may reveal the deceptive pleader's true feelings about the missing person, or may be a reaction to recollection of the crime scene. However, one must be cognizant not to speculate antecedents of emotional expression too wildly; visually identical expressions of disgust may follow exposure to anything from rotting meat to a moral transgression (Chapman et al., 2009). While facial expressions cannot reveal their source, what is clear is that expressions of disgust were much less likely to be expressed by genuine pleaders. This finding complements previous research that has described similar leakages of disgust during false descriptions of negative

videos and deceptive mock interviews (Ekman, Friesen, & O'Sullivan, 1988; Frank & Ekman, 1997).

Related to the failed emotional simulation prong of Darwin's (1872) hypothesis, deceptive individuals often were unable to express (upper and lower face) sadness. While genuine emotional distress triggered the expression of full-face sadness in most genuine pleaders, cortical commands to replicate this expression by deceptive pleaders often failed (Rinn, 1984). Thus, it appears that deceptive pleaders failed both in simulating sadness and in inhibiting their discordant emotions during this cognitively demanding performance.

4.1.2 Facial behaviour during direct appeal.

Of particular interest was the direct appeal portion of each plea during which the speaker asked the missing person to return home, asked the perpetrator to let the abducted individual go, or requested the public to assist with the search/investigation. This portion of the plea, provided by a guilty murderer – in contrast with descriptions of the missing person or details about the search, for example – can be confirmed as deceitful, given that he or she is intimately aware of the missing person's whereabouts and is responsible for his/her demise. As such, cues to deception were expected to be particularly salient during this portion of the plea, and distinct emotional expressions did discriminate liars from truth-tellers during this time. Deceptive murderers failed to simulate sadness accurately and exhibited lower face happiness (i.e., smiles). Simulated sadness more closely approximated surprise as expressed by the less controllable muscles of the upper face. Detailed coding of facial action units further elucidated those muscles that can reveal a false face.

4.1.2.1 Fabricated sadness.

Deceptive pleaders, attempting to replicate the complex activation of upper face sadness – contraction of the medial *frontalis* to raise the inner eyebrows and the *corrugator supercilli* to furrow the brows – could manage only crude approximations thereof. As predicted, based on Darwin's (1872) inhibition hypothesis and Rinn's (1984) description of upper face muscle innervation, the *frontalis* often was grossly activated, raising the entire brow. In other words, impulses emanating the upper facial muscles from the motor cortex, less under cortical control and with limited ability to perform intricate movements voluntarily, resulted in complete *frontalis* activation in what appears to be an expression of surprise but is better understood as a failed attempt to portray sadness among deceptive pleaders. Although full *frontalis* (AU 1+2) contraction was a strong predictor of deception, caution is warranted in the interpretation of brief eyebrow raises. People often use this movement voluntarily to emphasize their message (Ekman, 2003b). As such, a genuine pleader may briefly raise his/her eyebrows to accentuate the importance of volunteers in the search for the missing person, for example. Thus, it is important to note that AU 1+2 activation was not only more likely to be expressed by deceptive pleaders, it also pervaded a larger proportion of their direct appeal. While genuine pleaders may utilize brief AU 1+2 activations as speech emblems, deceptive individuals hold this expression for a greater duration in a failed attempt to express sadness. Attention to the *frontalis* movement may be more diagnostic if both duration and presence are considered, to avoid false positives (i.e., incorrectly classifying genuine pleaders as deceptive murderers).

In addition to a failure to replicate medial *frontalis* movement, activation of the *corrugator supercilli* muscles was less prominent in deceptive displays of duress. This muscle, bringing the inner eyebrows downward and together, was singled out by Darwin (1872) as a

muscle least under control of the will, and did indeed fail during such cognitively demanding deception. Genuine duress, on the other hand, was characterized by *corrugator supercilli* and *depressor anguli oris* activation, turning the lip corners downward. While most pleaders did not cry, the face still prepared for tears by narrowing the eyes to protect them from increased pressure and contorting the mouth for projection of a scream (Darwin, 1872). These actions, serving both a functional and communicative advantage, likely were prompted by activation of the extra-pyramidal motor system during such a genuine emotional experience (Rinn, 1984).

4.1.2.2 Inconsistent emotional leakage.

In addition to the failed expression of sadness, direct appeals were associated with the leakage of lower face happiness, or *zygomatic major* activation. Such facial activity was much less likely to occur during genuine appeals, and lasted for a shorter duration of the appeal, relative to deceptive pleaders. Although one might speculate that deceptive individuals revealed happiness at their relative's demise, or were experiencing duping delight, further analysis of the simultaneously activated muscles was necessary to determine whether such smirks represented a genuine emotional experience.

The distinction between genuine and falsified smiles is one of the most heavily-studied aspects of emotional facial deception, with the genuine smile reliably being found to include muscle action around the eyes (*obicularius oculi*; AU 6) that is not present in simulations of the emotion (Duchenne, 1862; Ekman et al., 1990). Genuine happiness (AU 6+12) occurred exceedingly rarely, for brief proportions of time, and did not differ across pleader credibility. As such, the smiles exhibited by deceptive individuals were more likely attempts to mask other emotional leakage (Ekman, 2003b). Indeed, during this pivotal portion of the plea, the deceptive

pleader may be particularly motivated to conceal the disgust that revealed itself in other sections of his/her complete plea and, thus, may resort to the use of masking smiles.

4.1.2.3 Attempts to conceal emotional leakage.

Although facial manipulators were rare in the present sample – particularly during the direct appeal – observation of deceptive pleaders suggests that they may use their hand to cover their face, particularly when their emotional mask begins to crack. For example, Canadian wife-killer Michael White covered his face and turned away from the camera after his attempts to appear distressed had failed and a genuine expression of anger spread across his face. Penny Boudreau used a facial tissue to cover her face in an apparent attempt to dry her non-existent tears during her falsified expression of sadness, and Paul Brown covered his face with his hands before fleeing the press conference room where he provided a deceptive appeal to find his missing baby. While such gestures occurred only rarely, attention to this behaviour in conjunction with emotional facial expression may provide the lie detector with valuable information.

4.1.3 Microexpressions.

Although the present study examined high-stakes, extremely emotional deception, the presence of microexpressions in direct appeals, as defined by Ekman (1992) remained rare, similar to lab-based research (Porter & ten Brinke, 2008; Porter, ten Brinke, & Wallace, 2012). Full-face microexpressions of sadness were expressed by only two pleaders, but were reliable predictors of truthfulness. Partial microexpressions communicating nearly all of the universal emotions occurred across genuine and deceptive pleas at some point; no clear patterns were present and the rarity of this phenomenon precluded meaningful statistical analyses. Although

Ekman (1992) potentially was correct in noting that the face can reveal one's true emotion, his rigid definition of microexpressions excludes much of the relevant information that can be gleaned from the face. Research suggests that the search for subtle emotional expressions without restrictions on duration, but revealing falsified and/or concealed affect, is a more effective approach to facial analysis in credibility assessment (Hurley & Frank, 2011; Porter & ten Brinke, 2008; ten Brinke, MacDonald et al., 2011).

4.1.4 Blink rate.

Similar to past research considering emotional masking (Porter & ten Brinke, 2008), deceptive pleaders blinked faster than genuinely distressed individuals, particularly during the direct appeal. However, this difference was not statistically significant due to the wide variation in mean blink rate across pleaders. This range, particularly amongst deceptive pleaders may be indicative of variation in deception strategies. Some liars in this situation may be motivated to conceal their genuine affect and replace its expression with falsified sadness (i.e., emotional masking), while others may recognize the futility of this task and instead attempt only to neutralize their true emotion.

Previous research has shown that these two strategies result in opposing blink rate patterns, relative to genuine emotions; neutralization decreases blink rate while masking increases the same (Porter & ten Brinke, 2008). Indeed, deceptive strategies may account for some of the conflicting results regarding blink rate in the literature; in DePaulo et al.'s (2003) seminal meta-analysis, blink rate was a non-significant predictor of veracity. However, effect sizes were not homogenous across studies. For example, blink rate has been shown to decrease during the concealment of guilty knowledge, both in a laboratory and real-world interrogation setting (Leal & Vrij, 2008; Mann et al., 2002). In both situations, participants or suspects are

likely to conceal their true emotions and adopt a "poker face" (i.e., emotional neutralization), denying any incriminating knowledge or criminal involvement. Previous research has attributed this result to increased cognitive load, or overzealous behavioural control (Holland & Tarlow, 1972; Leal & Vrij, 2008).

In contrast to consistent blink rate findings related to deceptive emotional neutralization, emotional masking has been linked to an increase in blink rate, and may be exhibited by deceptive pleaders falsifying sadness (Porter & ten Brinke, 2008). Such a result may be related to the emotional arousal associated with this complex emotional fabrication – a level of arousal that exceeds the cognitive resources available to control the leakage of blinking bursts. In sum, although blink rate did not differ significantly between genuine and deceptive pleaders, re-analysis upon classification of liars' strategies may serve to elucidate the relationship between this behaviour and emotional deception.

4.2 Consequences of Cognitive Load in Pleaders

Certainly, the production of a deceptive statement, with all its complexities, is more cognitively strenuous than telling the truth, potentially leading to signals of cognitive strain, including slowed speech, increased speech hesitations, and shorter statements (Vrij, 2008a, 2008b). It was expected that the task faced by deceptive pleaders was inherently cognitively demanding, requiring a command of language, body language, and facial expression that would far exceed that of a genuinely distressed individual. While indices of this expected cognitive demand were not evident across the entire plea, deceptive pleaders provided shorter direct appeals, both in terms of the duration and the number of words used, relative to genuine individuals. This approach commonly is employed by liars who attempt to limit the amount of information they provide, in order to reduce the amount of cognitive resources required to invent

this information and recall it in subsequent deceptive performances (DePaulo et al., 2003; Vrij, 2008a, 2008b).

Contrary to hypotheses regarding cognitive load, however, deceptive pleaders did not exhibit an increase in speech hesitations or a decrease in speech rate. Although predicted by the cognitive load theory of deceptive behaviour, these indicators receive less consistent support than response duration (DePaulo et al., 2003; Sporer & Schwandt, 2006), potentially due to the moderating effect of lie preparation. Some pleaders did attend their press conference with a prepared speech in hand, and others may have practiced in advance – attempting to perfect their dramatic performance in front of a mirror the evening before – without actually writing out their intended message and providing evidence of preparation in their public appearance. Regardless, it appears that speech duration is a robust indicator of deception, relevant in high-stakes emotional situations, but one that is limited to direct verbal communications of deception (i.e., direct appeals) rather than deceptive presentations in general (i.e., complete plea, playing the part of a distressed relative).

4.3 Consequences of Attempted Behavioural Control in Pleaders

Behaviours that can be consciously controlled may be subject to manipulation by the liar in an attempt to appear credible (Vrij, 2008a). For example, a liar who believes that fidgeting will signal his/her duplicity may constrain such movements. However, attempts to control such behaviour in order to appear credible may fail because liars are unaware of how they normally act, when truthful, resulting in overzealousness in their behavioural control. Overcompensation for deceptive behaviour may result in decreased movement (i.e., reduced use of illustrators) and exaggerated eye contact, for example (Mann et al., 2011). Amongst pleaders, such behaviours did not discriminate liars from truth-tellers either during the complete plea or direct appeal. In

general, the use of illustrators was rare. This may be due in part to variation in the angle of filming, which precluded coding this variable when the pleader was recorded from less than the waist up. Thus, while illustrator use has been a reliable indicator of deception in predominantly unmotivated student samples, this pattern does not appear to translate to high-stakes situations (Davis & Hadiks, 1995; DePaulo et al., 2003; Mann et al., 2002; Porter & ten Brinke, 2008).

Gaze aversion – the most commonly cited cue to deception the world over (Global Deception Research Team, 2006) – has received no empirical support in past research despite its colloquial popularity as an indicator of deception (DePaulo et al., 2003). Here, gaze aversion was generally defined as the proportion of time that the pleader avoided eye contact with the camera, crowd to whom they spoke, and the interviewer (if one was present). In other words, gaze aversion was operationally defined as any instance in which pleaders looked in an upward or downward direction where people were not present. Although not a statistically significant difference, deceptive pleaders did engage in approximately twice as much gaze aversion during their direct appeals, on average. While this may be interpreted as tentative support for the colloquial notion that the liar "can't look you in the eye," and the possibility that eye contact exacerbates the arousal associated with deception, an alternative emotional arousal hypothesis, may be more relevant in this context.

4.3.1 Alternative explanation of deceivers' body language.

Looking downward, and away from others, is a hallmark of shame and is cross-culturally recognized as a signal of this self-evaluative emotion (Keltner, 1995; Tracy & Robins, 2008). Both sighted and congenitally blind athletes from around the world show remarkably similar body language expressions of pride or shame, depending on the outcome of a recently completed match, suggesting that this spontaneous posture is an innate and universal expression (Tracy &

Matsumoto, 2008). Similar to a "cringing" posture sometimes adopted by other species in similar powerless situations (e.g., chimpanzees, baboons, wolves; de Waal, 1989; Maslow, 1936), it has been posited that this expression once served an adaptive function for the bearer, protecting one's body from harm by adopting a closed posture and signaling that they are submissive to the victor. As such, gaze aversion, if exhibited in the downward direction, may be a "leakage" of genuine shame on the part of the deceptive pleaders, revealing their negative self-evaluation at their murderous actions.

4.4 Consequences of Psychological Distancing in Pleaders

The verbal content of a message has long been considered an important aspect of a credibility assessment and contemporary research has highlighted the superiority of verbal cues over body language cues, particularly when observers are not trained in empirically-valid indicators of deception (Vrij, 2008b; Vrij et al., 2011). Although past research in this regard generally has examined lengthy narratives, using CBCA or RM (Johnson & Raye, 1981; Steller & Kohnken, 1989), these techniques are not appropriate for short utterances such as public appeals for missing individuals. Instead, the verbal content was examined for linguistic markers of psychological distancing. That is, (presumably unconscious) attempts by the liar to make his/her performance easier by avoiding personal responsibility for their duplicity. Deceptive pleaders were expected to do so by reducing their use of pronouns, emotional words, and increasing their use of tentative, non-committal words. However, only the use of tentative words was a significant predictor of pleader veracity. Individuals concealing their involvement in a missing relative's murder used a far greater proportion of tentative words both in their complete plea and during the direct appeal specifically. For example, Penny Boudreau provided a plea to her daughter that was littered in tentative language, saying: "I don't know where you are, but *just*

come home *or* call *or something*, please." This finding is consistent with previous research by Zhou and colleagues (2004) and further promotes the application of linguistic analysis to the study of deception (Tausczik & Pennebaker, 2010). While we have focused on psychological distancing here, future research may examine additional theoretical perspectives, relevant to deception, which may be revealed by a liar's linguistic choices. For example, if cases were limited to instances where the relative's body has not yet been found at the time of the press conference, past tense references to the missing person may reveal guilty knowledge that the individual is deceased (Adams, 1996).

4.5 Multiple Cue Approach to Detecting Deception

Given that behavioural indices of deception generally are subtle, difficult to detect, and imperfect predictors of veracity, the use of multiple cues has been promoted to enhance accuracy of credibility assessments in applied settings (Hartwig & Bond, 2011; Porter & ten Brinke, 2010; Vrij et al., 2011). Although this recommendation may sound obvious, deceptive cues that reveal the same underlying theoretical construct may explain redundant variance between liars and truth-tellers, and attention to both cues may erroneously bolster the lie detector with undue confidence in his or her assessment. As such, it was considered to be an important aspect of this research to examine the unique contribution of each behavioural cue to a determination of veracity.

The combined presence of upper face surprise, lower face happiness, a decreased number of words, and increased proportion of tentative words in the direct appeal discriminated between liars and truth-tellers at an unprecedented rate in the study of deception. Each of these cues explained unique variance, contributing to the correct classification of 90% of cases. A reduced plea length (in words) serves as an indicator of liars' increased cognitive load and the increased

use of tentative words signals liars' attempts to create a psychological distance between themselves and the content of their lie. The presence of surprise (i.e., failed attempts to appear sad) and happiness represent the deceptive pleader's unique emotional arousal and, more specifically, relate to each prong of the inhibition hypothesis. Attempts to portray sadness, particularly among the muscles of the forehead that are under limited cortical control, were likely to fail. Contraction of the complete *frontalis*, rather than only the medial *frontalis* as in genuine sadness, was likely to make the deceptive pleader appear surprised, provided support for one prong of Darwin's (1872) inhibition hypothesis, and accounted for unique variance in the discrimination of veracity. The complementary prong, regarding the leakage of genuine emotion, is supported by the presence of smiles in the deceptive pleader's lower face. Although further analysis revealed that these smiles were not genuine in nature (i.e., they did not include simultaneous *obicularius occuli* contraction), they are presumed to be masking smiles, intended to stifle the leakage of some other genuine emotion from revealing itself on the face. The presence of such smiles was a marginally significant predictor of veracity and, while sharing a theoretical origin with the presence of surprise, represented a distinct aspect of the liar's emotional experience.

The combination of variables appears to be more effective in classifying pleaders than any one cue alone. For example, the presence of complete *frontalis* activation (i.e., AU 1+2) correctly classified less than 70% of cases correctly and with a high rate of misses (classifying deceptive pleaders as genuine). Smiles (i.e., AU 12), too, correctly discriminated only about 70% of liars and truth-tellers correctly, with a similar miss rate. As such, it appears that the combination of multiple cues (facial and otherwise) increases discrimination accuracy both by increasing hit rate (90%) and decreasing misses (10%).

4.5.1 Caution in interpreting classification rate.

To my knowledge, the combination of these empirically-supported cues has led to the highest rate of veracity classification yet reported in the deception literature. This is likely a result of the use of multiple cues, tapping different theoretical constructs, and the nature of the sample – the examination of high-stakes emotional lies where motivational impairment is likely to accentuate cues to deception (DePaulo et al., 1988; Porter & ten Brinke, 2010). While encouraging to researchers and law enforcement alike, words of caution are warranted. First, the cues included in this prediction model were chosen because they were significantly different across veracities in this sample. Although all were a priori theoretical predictions, it is possible that another sample of pleaders would not differ on these behavioural cues, thus reducing the effectiveness of these predictors in future samples. While the present analyses serve as convincing support for the multiple cue approach, generally, validation of this set of predictors on additional samples of pleader cases is necessary to conclude that such cases can be reliably classified based on the presence of upper face surprise, lower face happiness, a decreased number of words, and an increased proportion of tentative words in the direct appeal.

While it is likely that the cues chosen for this model will apply to future samples of pleaders to some extent, it is less likely that this model will generalize to different situations. For example, guilty suspects who attempt to deny any criminal involvement may provide short alibis with a high proportion of tentative words, but are likely to neutralize, rather than mask, their emotions. As such, the failed expression of sadness, which is highly relevant to the present sample of pleaders, is not likely to be pertinent in a deceptive denial situation. Although facial indicators are still likely to reveal emotional deception in this situation, the lie detector would be wise to look for leakage of genuine emotions, rather than the failed falsification of insincere

emotional expressions (Frank & Ekman, 1997; Hurley & Frank, 2011). In general, the facial indicators of deception will be highly variable across situations, depending on the emotions to be concealed and fabricated, if any. However, an understanding of Darwin's (1872) inhibition hypothesis, combined with an understanding of human facial innervation (Rinn, 1984), can provide the lie detector with theoretically grounded hypotheses for detecting emotional lies. For example, armed with the knowledge that the upper face is under less cortical control than the lower face, the lie detector may focus his/her attention to the *corrugator supercilli*, expecting this muscle to leak indications of the genuine anger concealed by a suspect who denies involvement in a crime of passion.

4.5.2 Enhancing classification accuracy.

Although the classification of the pleaders studied here was highly successful, room for improvement still exists. Particularly when the cues to deception are subtle and difficult to detect, naïve observers commonly perform at the level of chance (i.e., ~50%) in deception detection tasks (Bond & DePaulo, 2006; DePaulo et al., 2003; Ekman & O'Sullivan, 1991; Hartwig & Bond, 2011). While individual differences in deceptive behaviour may be considered a limitation of the present research, accounting for variance associated with relevant personality characteristics may actually serve to enhance prediction accuracy. For example, it is known that psychopathy is associated with affective deficits that both decrease the likelihood of genuine emotional leakage and increase the possibility of failed emotional simulation (Porter, ten Brinke, Baker, & Wallace, 2011). Further, research suggests that psychopathy also influences verbal cues to deception and blink rate during emotional neutralization (Porter & Woodworth, 2007; ten Brinke, Wallace, & Porter, 2011). As such, a consideration of a suspect's psychopathic traits

may allow the investigator to tailor their interpretation of behaviour, and come to a more accurate classification of veracity.

Alternatively, 'active' strategies may be utilized by the investigator to take control of the suspect interview, with the aim of increasing the difficulty of lying and exacerbating leakage for the greater discrimination of liars and truth-tellers. For example, Vrij and colleagues (2008) increased cognitive difficulty by asking liars and truth-tellers to relate their alibi for the accused transgression in reverse order. Liars found this task particularly difficult and behavioural manifestations of this challenge (e.g., fewer details, increased speech hesitations) were significantly increased relative to liars in the forward-telling condition. Importantly, these behaviours were apparent even to untrained deception detectors who performed above the level of chance in detecting deceptive reverse, but not forward-order, narratives. Asking deceivers unanticipated questions or instructing them to maintain eye contact have similar effects (Vrij et al., 2009, 2010). Further, it has been proposed that introducing a simultaneous motor task (e.g., lying while driving) will also increase the saliency of cues to deception given the depletion of cognitive resources required to complete both tasks successfully (Vrij, Fisher, et al., 2008).

While promising, the cognitive load approach manipulates only one antecedent of deceptive behaviour, and the multiple cue approach studied here suggests that manipulations tapping several theoretical constructs simultaneously may be more successful. The social psychological literature suggests that power manipulations may provide a more comprehensive avenue for active interviewing to detect deception. Socially dominant individuals naturally are better at interpreting others' intentions, persuading others, and deceiving others, allowing them to control the low-status masses (Keating & Heltman, 1994). To be successful, a high-status leader should be able to lie to his/her subordinates with little cognitive effort and few feelings of

guilt or nervousness, thereby appearing normal and, importantly, credible (Hirsh, Galinsky, & Zhong, 2011). In short, the dominant individual should not experience those characteristics of deception that produce leakage in situations where they experience feelings of power.

In the first examination of the effect of power on deceptive behaviour, Carney, Yap, Lucas, and Mehta (2010) found that individuals randomly assigned to leadership positions in a laboratory task and subsequently asked to lie about a transgression (i.e., stealing $100) were indistinguishable from truth-tellers. In contrast, liars assigned to a subordinate condition showed higher cortisol levels, reported more negative feelings, spoke more quickly and experienced heightened cognitive impairment, relative to high-power liars and truth-tellers. While these results suggest the troubling possibility that high-powered individuals may lie easily, and with few behavioural 'tells,' results also provide lie detectors with a potentially useful manipulation. Inducing feelings of powerlessness in the pleader, either by interpersonal or environmental manipulations, may serve to exacerbate indices of deception in the liar who is already feeling the high arousal and heavy cognitive load associated with telling such an elaborate, emotional lie. As such, classification accuracy – both statistically and simply by observer judgment – may be amplified (Vrij, Mann, et al., 2008).

4.5.3 Classification summary.

Although the generalizability of the classification rate found here remains to be empirically examined, it is clear that attention to the face, as well as the verbal content of a potential lie, can be valuable weapons in the lie detector's arsenal. This work bolsters, and extends, previous findings by Ekman et al. (1991) who found that a combination of genuine and deceptive smile presence, and voice pitch could classify 86% of nurses motivated to lie about their emotional reactions to a pleasant or disgusting video. As such, it appears that the multiple-

cue approach is strongly supported, and should be encouraged in applied settings (Vrij et al., 2011).

4.6 Application of Findings in Real-World Contexts

While investigators scrutinized the behaviour of the innocent Vernon Mccumber, the real murderer sat by his side. Penny Boudreau played the part of a distressed mother and the close-knit community of Bridgewater rallied behind her in a desperate search for her daughter, Karissa. As the search wore on for nearly two weeks, Penny continued to harbour her horrific secret – that she had killed her daughter and staged it as a sexual assault, an extreme reaction to her boyfriend's ultimatum that she choose between him or her daughter if she wanted to save their relationship (CBC News, 2009). While a comprehensive credibility assessment of Penny's televised appeal to her daughter cannot replace a thorough police investigation, such an analysis may have saved the local RCMP force time and money, and may have brought Penny to justice sooner. Indeed, the present author – as a Nova Scotian and student of Dalhousie University at the time of the appeal – followed the case closely and noticed several concerning aspects of Penny's behavioural presentation immediately. Her expression of sadness was incomplete, she leaked smirks, and she covered her face with a tissue although she did not appear to be crying. An individual trained in the detection and importance of such cues may be able to raise similar doubts to investigators in future cases and steer the investigation in an advantageous direction, for the efficient and effective clearance of heinous crimes.

4.6.1 The search for Amber Kirwan.

As I write, the small town of New Glasgow, Nova Scotia – 30 minutes from my childhood home – enters its second week of searching for missing 19-year-old Amber Kirwan.

Amber left the local pool hall around 1:30 am on Thanksgiving Sunday, presumably on her way to meet her boyfriend at a nearby convenience store. However, she never arrived at the destination and was reported missing by her family that evening (CBC News, 2011a). Currently, suspicion surrounds Amber's live-in boyfriend, Mason Campbell, who has been vocal with the media and an active member of the search (CBC News, 2011b). While he says that he understands the suspicion, Mason maintains his innocence and contends that he has been completely honest in several interviews with police. This case represents precisely the situation in which a comprehensive behavioural analysis may serve to complement a police investigation. Indeed, the careful analysis of Mason Campbell's face, body language, and verbal/linguistic behaviour, may assist police in the search for Amber and her suspected abductor.

4.6.2 Training professionals to detect deception.

While an expert analysis of every such case may be ideal, it often is not practical in applied settings. Fortunately, short training seminars have been shown to be useful in increasing previously naïve observers' ability to detect such high-stakes emotional deception (Porter et al., 2000). As noted in previous chapters, a one-day workshop including (a) myth dissolution, (b) a detailed discussion of empirically-validated cues to deception, particularly in respect to the behaviour of pleaders, and (c) deception detection practice, led to significant post-training gains. After training, participants were able to discriminate between genuine and deceptive pleaders at 80.8% accuracy, relative to chance-level accuracy (~50%) pre-training (Shaw et al., 2011). Without a background in deception or emotional facial expression, participants were able to detect facial, body language, and verbal/linguistic cues, and use this information to inform their credibility assessments. While additional research is necessary to examine the long-term and

real-world impacts of such training, this finding is an important step in the eventual application of behavioural deception detection approaches in real-world contexts.

This recommended approach to training and application in real-world settings is in contrast with that of the SPOT (Screening Passengers by Observation Technique) program. Despite the paucity of peer-reviewed, empirical research at the time, the United States Transportation Security Administration (TSA) implemented this behavioural detection program with a focus on (micro) facial expression analysis in airports across the country following the September 11, 2001 terrorist attacks. In consultation with Dr. Paul Ekman, security officials reasoned that if emotional expression could be "read," a passenger with malicious intentions could be identified by brief expressions of anger or fear on his/her face. Officials trained in this approach, began putting their new skills to use in 2006; this program currently is utilized in 161 airports in the US (Segura, 2009; TSA, 2011). However, the efficacy of the program is up for debate. While the TSA boasts that the technique has led to the arrest of wanted criminals (TSA, 2007a) and illegal immigrants (TSA, 2007b), it has done so at a high price. The 3.1 million dollar program identified nearly 99,000 suspicious passengers in 2008 alone. Of those suspicious passengers, only 813 were arrested and fewer still convicted of any illegal activity (Segura, 2009). One of the problems facing the large-scale examination of facial expression in an uncontrolled environment, as noted by Ekman (2006), is that fleeting emotional expressions do not reveal their source, making benign behaviours appear suspicious. In the hustle and bustle of an airport there are a myriad of reasons to be exasperated, frustrated, and down-right angry without harbouring terrorist intentions – a missing piece of luggage, a delayed flight, or the mournful travel home for a family funeral could be sufficient reason to be classified as suspicious by a SPOT officer. Research in Chapter 2 – the first to examine the presence of microexpressions in an emotional high-stakes sample – further suggests that these false

identifications may be due to incorrect assumptions about the utility of the microexpression as a cue to deception; these expressions are not frequent or reliable indicators of veracity even in controlled environments (see also Porter & ten Brinke, 2008; Porter, ten Brinke, & Wallace, 2012; ten Brinke, MacDonald et al., 2011). As such, innocent individuals, detained for further questioning, face further frustration and missed flights at best, and human rights violations at worst. Based on outcomes of the SPOT program and accumulating research on the efficacy of microexpressions as a cue to emotional concealment, it is clear that a more cautious approach to facial analysis in applied settings is warranted.

4.7 Summary and Implications

The present dissertation is a significant step forward in the study of deception and our understanding of human communication more generally. With a sample of 78 pleaders subjected to frame-by-frame analysis of facial, body language, and speech behaviours, this work is by far the largest and most comprehensive examination of high-stakes deception to date. In comparison, Mann et al.'s (2002) study of high-stakes lies during police interviews included 16 suspects and did not consider facial or linguistic indices of deception. The present investigation addresses the dearth of research in the area of high-stakes lies and makes the responsible application of behavioural deception detection in applied settings a realistic possibility.

In combination with other cues, including indicators of cognitive load and psychological distancing, predictions stemming from Darwin's (1872) inhibition hypothesis and Rinn's (1984) description of human facial innervation can correctly classify the veracity of 90% of pleaders correctly. Although the generalizability of this finding has yet to be tested with alternative samples, this finding provides strong support for the multiple cue approach (Porter & ten Brinke,

2010) and suggests that the responsible use of this information may be helpful in assisting investigators to solve major crimes.

More generally, the present work establishes the analysis of emotional facial expression as an integral part of credibility assessment and highlights the importance of attention to the face in the detection of emotional lies, specifically. Following the premature application of facial analysis to security procedures in airports, many have criticized the analysis of facial expression as a cue to deception (Weinberger, 2010). While it is clear that there are limitations to facial deception detection, it also can be a valuable addition to a credibility assessment when rooted in empirical research. Thus, despite some controversy about the utility of attention to the face in deception detection tasks, researchers and investigators alike would be wise not to dismiss information gained from the face too easily.

The impact of the genius of Charles Darwin on the study of emotional facial expression cannot be understated. Inspired by Duchenne (1862), Darwin's (1872) *Expression of the Emotions in Man and Animals* laid the foundation for the subsequent empirical investigation of the universality of emotional expression, the functional and adaptive qualities of these expressions, and the ways in which the face may reveal a false emotion (Ekman 2003a, 2009). Indeed, it appears that those muscles of the face least under cortical control are vulnerable to failure during cognitively demanding tasks such as high-stakes deceit. Combined with our contemporary understanding of human facial innervation (Rinn, 1984; Hurley & Frank, 2011), the lie detector's attention may be guided towards theoretically and empirically relevant muscles that reveal credibility. The present dissertation continues to unravel the secrets of the human face, and human communication more generally, with the potential applied benefit of efficient and effective identification of deception in high-stakes settings.

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