



The truth about lies: What works in detecting high-stakes deception?

Stephen Porter* and Leanne ten Brinke

University of British Columbia Okanagan, Kelowna, British Columbia, Canada

In this paper, we provide our view of the current understanding of high-stakes lies often occurring in forensic contexts. We underscore the importance of avoiding widespread pitfalls of deception detection and challenging prevailing assumptions concerning strategies for catching liars. The promise and limitations of each of non-verbal/body language, facial, verbal/linguistic, and physiological channels in detecting deception are discussed. In observing the absence of a single cue or behavioural channel that consistently reveals deception, a holistic approach with concurrent attention to multiple channels of a target's behaviour (ideally videotaped for review) and changes from baseline behaviour is recommended whenever possible. Among the best-validated cues to be considered together include: illustrators, blink and pause rate, speech rate, vague descriptions, repeated details, contextual embedding, reproduction of conversations, and emotional 'leakage' in the face. While advocating a reliance on empirical evidence, we observe that few studies of high-stakes deception yet have been conducted. Further, some manifestations of lying are highly idiosyncratic and difficult to address in quantitative research, pointing to the need for keen observation skills, and psychological insight. A recurring theme is the need for the field to devise innovative approaches for studying high-stakes lies to promote ecological validity. Ultimately, such work will provide a strong foundation for the responsible application of deception research in forensic and security settings.

Unless you happen to live on a desert island and this issue of *Legal and Criminological Psychology* arrived in a bottle, chances are good that you have been lied to and possibly used deception at some point today. Deception is a major aspect of social interaction; people admit to using it in 14% of emails, 27% of face-to-face interactions, and 37% of phone calls (Hancock, 2007), and lie on average about twice a day (DePaulo, Kashy, Kirkendol, Wyer, & Epstein, 1996). Thus, unlike most of the specialized topics covered in this special issue, deception is not specific to the forensic context; it is a fundamental aspect of human behaviour likely having emerged early in human evolutionary history (e.g. Livingstone Smith, 2004). Given the scale of interpersonal deception and the extensive research devoted to its study (see Vrij, 2008a), writing a journal article on 'what

* Correspondence should be addressed to Dr Stephen Porter, University of British Columbia Okanagan, 3333 University Way, Kelowna, BC, Canada (e-mail: sbporter@dal.ca).

works' in deception detection initially seemed daunting. Our focus here, however, is not on ubiquitous and well-studied everyday lies – most of which are never caught, nor, one might argue, should they be – but rather on what might work in catching serious lies of serious consequences – those concerning criminal, or even terrorist, activity.

High-stakes lies should be easy to spot . . . but they're not

Research on high-stakes lies is embryonic relative to that of trivial ones. Although there remains much to learn about such lies, a critical truism is that 'deceptive behaviour' can depend heavily on the potential outcome for the liar. Lies of consequence generally are more difficult to tell than other lies and should be accompanied by more salient behavioural signs, or 'leakage' (the 'motivational impairment effect'; DePaulo & Kirkendol, 1989), discernable to the informed observer. Lying about one's knowledge of a committed or planned crime can be a complex undertaking and enormously stressful for most people. Telling such lies entails a tough acting job; the liar must concurrently keep the details of his/her lines straight and appear 'credible' to a potentially apprehensive listener whose conclusion about the deceiver's veracity may determine his/her fate. Many high-stakes lies are accompanied by powerful emotions – fear, remorse, anger, or even excitement – that must be inhibited and/or convincingly faked. Consider the would-be terrorist, smiling and chatting politely with airport staff while covertly feeling intense hatred and contempt towards his intended targets, and perhaps fear of discovery and/or death. Or the mother publicly pleading for the safe return of a child who, in reality, she has murdered. Each of these liars must concurrently monitor his/her body language, facial expressions, and stories while dealing with an awareness of the potent consequences of getting caught.

This complex blend of affective and cognitive elements required for such high-stakes lies potentially is good news for the lie catcher. Yet, observers often do not see through such masquerades. Soon after killing his pregnant wife Liana in 2005, Michael White gave a videotaped statement to the Canadian media pleading with apparent anguish for her safe return and eliciting widespread sympathy. After overwhelming evidence linked him to Liana's murder, her mother commented that the plea had 'fooled us all' (The Canadian Press, 2006). During the 1938 meeting in Munich, Neville Chamberlain scrutinized Hitler's face as Hitler swore that he would not invade Czechoslovakia, concluding 'I got the impression that here was a man who could be relied upon when he had given his word' (see Ekman, 1992); a deception detection failure that contributed to a global catastrophe. While Liana's mother and Chamberlain were amateur lie catchers (regarding the latter, politicians are better known for their skill at lying than at spotting lies), even trained professional lie catchers often fail in detecting high-stakes lies. When Vrij and Mann (2001a) showed clips of White-type 'pleaders' to police officers to evaluate their truthfulness, the officers could have flipped a coin and performed as well. Indirect evidence suggests that these findings based on passive judgment tasks – a common critique levelled against deception research – may play out in forensic interviews. For example, psychopaths – who have a high recidivism rate and lie prodigiously – are more than twice as likely as their non-psychopathic counterparts to be granted parole after the parole interview (Porter, ten Brinke, & Wilson, 2009). While some research has indicated that certain professional groups (e.g. see Ekman & O'Sullivan, 1991; Ekman, O'Sullivan, & Frank, 1999; Mann, Vrij, & Bull, 2004) and individuals, or 'wizards' (O'Sullivan & Ekman, 2004), are better than chance at detecting lies (but see Bond & Uysal, 2007), the typical pattern is one of mediocre performance sometimes combined with inflated confidence, a formula for disaster in forensic settings.

So given our premise that the behavioural consequences of high-stakes lies should be more salient than those of trivial ones, why are they so often successful? For one thing, even if high-stakes lies are accompanied by elevated cue salience, their identification may not translate into an easy task if observers do not know what to look for. Yet, the Supreme Court of Canada concluded that mere common sense was needed for jurors to identify a deceptive witness (*R. v. Marquard*, 1993), so long as his/her face and demeanour were observable (*R. v. B. (K.G.)*, 1993). Further, we and other groups have found that judges and other legal decision makers report beliefs concerning 'valid cues' to deception that are completely false (e.g. Porter & ten Brinke, 2009). Obliterating the common sense judicial notion, a string of ensuing wrongful convictions clearly were caused, in part, by the testimony of 'smooth and convincing' liars (Wilson, 2003). Further complicating the task is the observation that the behavioural manifestations of lies may not occur on a linear continuum according to their gravity. That is, there may be qualitative, as well as quantitative, variations in the behavioural manifestations of lies of minor and major consequence. As we will explore, research shows that lying about serious crimes can generate behavioural patterns discordant with those traditionally identified in the broader deception literature (e.g. Mann, Vrij, & Bull, 2002). So although high-stakes lies subjectively may be harder for liars to tell, their behavioural manifestations are neither obvious nor necessarily simply magnified versions of those of lower stakes lies.

A final factor that helps to explain the problems that plague the detection of high stakes lies is that there is no 'Pinochio's nose'; no behavioural channel lends itself to simple decision rules in detecting lies (Vrij, 2008a). One of the most widely cited body language cues associated with deception is the 'illustrator', or controllable hand and arm gestures. DePaulo *et al.*'s (2003) major review found that liars tend to use fewer illustrators than truth tellers. Despite the potential utility of the illustrator, however, caution is warranted in extending existing relevant findings to high-stakes lies, criminal populations, or other skilled deceivers. The illustrator's potential utility is maximized with the knowledge that it does tend to change in frequency during lying and that its manifestations are contingent on individual differences and contextual variables. Anecdotally, it appears that some sophisticated liars use illustrators or other voluntary movements in an *active* way to enhance their credibility and/or distract attention from their high-stakes story. Consider Bill Clinton as he lied about the Lewinsky affair; he waved his finger several times as he stated he 'did not have sexual relations with that woman', showing a burst of illustrator use (Nazi Adolf Eichmann showed a similar deception pattern in his interrogations; see Porter & Yuille, 1996). However, a case study of Saddam Hussein during a CNN interview indicated that - in accordance with the typical pattern reported by DePaulo *et al.* - he markedly reduced his illustrator use when lying (Davis & Hadiks, 1995), unlike Clinton's finger-wagging. Thus, while the broad literature on low-stakes deception suggests a reduction in illustrators, high-stakes lies by Saddam and Clinton were accompanied by a decrease and increase respectively. Clearly, variations in patterns across individuals and context further complicate the would-be lie detector's task. However, knowledge of individual and contextual factors influencing behaviour is an important step towards improving one's chance of catching high-stakes lies.

Applying deception research and challenging assumptions in practice . . . and in science

Two questions must be considered in deciding whether existing scientific knowledge concerning deception detection can be successfully applied in forensic contexts.

First, has research addressed the manner in which decision makers attempt to catch liars (as a result of experience, traditional training, or 'natural' strategies) and the major pitfalls that can lead to their mistakes? Further, are there evidence-based strategies that could improve upon existing practices and pitfalls? The first inquiry clearly warrants a positive response. To the second, strong optimism is warranted, with the caveat that the body of research on high-stakes lies with forensic populations is in its infancy. There is good reason to believe that behavioural manifestations of deception may differ between students, who often serve as participants in deception studies, and forensic populations. Criminal offenders sometimes re-tell major lies for years (Porter & Woodworth, 2007), have more valid knowledge about deception, consider lying to require less effort compared to others, and outperform students on deception detection tasks (Granhag, Andersson, Stromwall, & Hartwig, 2004; Hartwig, Granhag, Stromwall, & Andersson, 2004). Thus, as the field moves forward and knowledge on lying in forensic contexts grows, a constant goal should be to bridge the gaps between science and practice. Further, the publication of research challenging widespread assumptions about deception detection is essential, as is its communication to relevant professional groups. For example, research on the validity of Reid technique in identifying deceptive suspects – taught to hundreds of thousands of investigators internationally (John E. Reid & Associates, 2004) – has belied its major limitations (Kassin & Fong, 1999; Vrij, Mann, & Fisher, 2006). While such research often is met with skepticism by stakeholders and practitioners, at least it can lead to much-needed debate and self-reflection in the field (Blair & Kooi, 2004).

We also are compelled to engage in some (self) criticism of the deception research field which itself has been guilty of sometimes maintaining unsupported assumptions, exemplified for convenience by two observations from our own work. One example concerns motivation; it has long seemed obvious that successful lie catchers must be highly motivated (e.g. Granhag & Stromwall, 2004). But what if excessive enthusiasm can impair one's ability to detect lies by increasing tunnel vision? In a recent study, we manipulated lie catchers' motivation level prior to a deception detection task. Contrary to the prevailing doctrine, excessive motivation decreased their accuracy and increased confidence in their assessments – obviously, a dangerous combination resembling 'tunnel vision' (Porter, McCabe, Woodworth, & Peace, 2007). Secondly, we, like most everyone else it seemed, presumed the firm empirical foundation of the validity of micro-expressions in relation to deception. But in 2006, despite reading of anecdotal evidence, we were unable to find any published empirical research on the phenomenon. For decades, the idea had been embraced with an extraordinary non-critical following in the scientific community, law enforcement, and, most recently, airport security (Porter & ten Brinke, 2008). While such an approach has much potential value, we think its implementation was premature given the aforementioned lack of empirical attention it had received. So we began to study micro-expressions and facial expressions, more generally, as a potential deception detection tool. While our findings supported the existence of Ekman micro-expressions, extensive coding of nearly 700 genuine and falsified emotional expressions revealed that they occurred in only 2% of expressions, and sometimes apparently meaninglessly in genuine expressions ('false positives'). All prevailing assumptions about lying – outside and within our field – must be questioned empirically.

In moving forward in the field of deception detection, our previous oversights can serve as important lessons when evaluating new methods and phenomena touted as the Pinocchio's nose for which the field has been searching. Currently, a spotlight is shining

upon neuroscientists who have begun to examine brain function using neuroimaging such as functional Magnetic Resonance Imaging (fMRI) as a means of detecting lies (see Iacono, 2008; Vrij, 2008a). The rationale for this approach is that areas of the brain associated with recognition memory will be activated in a perpetrator but not an innocent suspect when confronted with crime-related information (Wolpe, Foster, & Langleben, 2005). The general picture emerging from the early work is that deceptive knowledge is associated with increased prefrontal, parietal, and anterior cingulate cortex activation (Langleben *et al.*, 2002; Spence *et al.*, 2004). Inevitably, companies have begun to offer fMRI deception detection services to investigators; two companies – Cephos in Massachusetts and No Lie MRI in California – claim to determine with at least 90% accuracy whether a subject is telling the truth (Stix, 2008). However, fewer than twenty published studies have examined brain function during deception, leading to justifiable warnings concerning the premature application of neuroimaging technology in the legal system (Greely & Illes, 2007; Wolpe *et al.*, 2005). Specifically, Spence (2008) points to problems with replication, large individual brain differences and no clear brain regions associated with truth telling. Nonetheless, India has become the first country to convict someone of a crime based on neuroscientific evidence. The defendant, Aditi Sharma, was accused of killing her former fiancé, Udit Bharati, by poisoning his food. Using a guilty knowledge approach, investigators placed 32 electrodes on her head and read aloud their version of events, making such first-person statements as ‘I bought arsenic’ and ‘I met Udit at McDonald’s’, along with neutral statements like ‘The sky is blue’. This approach apparently builds on previous Electroencephalogram methods that measure the amplitude of P300 electrical brain wave responses to concealed autobiographical and incidentally acquired information (Giridharadas, 2008). The judge agreed that this test proved ‘experiential knowledge’ of committing the murder and corroborated other evidence.

Given the alarming emergence of this type of evidence in the courtroom, there is an urgent need for independent research on its validity and the generalizability of existing findings (Greely & Illes, 2007; Rosenfeld, 2005). Despite the potential of fMRI as a lie detection tool, existing studies have used low-stakes, artificial tasks and small, homogenous groups of relatively unmotivated participants. Further, they often have used traditional polygraph-style questioning methods, suggesting similar theoretical shortcomings and potential susceptibility to countermeasures (Wolpe *et al.*, 2005). However, there is a high demand for objective lie detection methods and, with the rapid maturation of neuroimaging tools, such a technique might not be far in the future (for a detailed discussion of fMRI as a lie detection tool, see the invited Langleben, 2008 versus Spence, 2008 debate in *Legal and Criminological Psychology*). In the meantime, researchers must design studies that offer a high level of internal validity complemented by research with high-stakes liars, and seek converging evidence. If differences in the brain function of truth-tellers and liars are reliable, neuroimaging indeed will become a major weapon in the deception detection arsenal.

Some systemic and natural pitfalls in detecting lies

In ameliorating the apparent problems of detecting lies in forensic settings, the manner in which mistakes so often get made must be elucidated. One major problem is the widespread implementation of tools and training of questionable validity that can actively lead to errors, to the extent of eliciting poor, even below-chance performance (e.g. Kassin, 2008; Kassin & Fong, 1999; Porter, Woodworth, & Birt, 2000). Clearly,

approaches involving coercion or torture – endorsed by many governments around the world – not only are unethical but also largely ineffective in discriminating liars and truth-tellers, particularly in terms of false positive errors including false confessions (Costanzo, Gerrity, & Lykes, 2007; Kassin, 2005). This problem also plagues the polygraph, the most widely used technological tool for discriminating liars and truth-tellers. While it is not without merit (for example, it can elicit valid confessions from some perpetrators), laboratory and field studies suggest that the control question test (CQT) suffers from a high false positive rate, often classifying honest suspects as being deceptive, while the guilty knowledge test (generally viewed as a better but under-used alternative to the CQT) under-identifies liars, exhibiting false negative errors (Elaad, Ginton, & Ben-Shakhar, 1994; Iacono, 2008; MacLaren, 2001; Vrij, 2008a). Although space precludes a thorough review here, the weak theoretical basis of common interview techniques, tenuous relationship between nervousness and deception, lack of test and scoring standardization, use of approximate measures of ground truth and successful countermeasures have, with some exceptions (e.g. Honts, 2004), led to a general skepticism of polygraphy in the field of psychology and law (e.g. Ben-Shakhar, 2008; Iacono, 2008; Vrij, 2008a). Other physiology-based approaches such as Voice Stress Analysis are largely ineffective in discriminating liars and truth-tellers (Gamer, Rill, Vossel, & Godert, 2006), likely for the same reason as polygraphy – physiological reactions associated with nervousness do not always accompany lies, and truth-tellers often experience contextual arousal unrelated to deception.

A second line of work relevant to understanding pitfalls in catching liars has focused on more ‘natural’ biases in legal decision-making (see Vrij, 2008a). It long has been recognized that human decision-making in general can be irrational (e.g. Kahneman & Tversky, 1982) and that such irrationality is witnessed in forensic contexts (see also the contribution by Alison, Goodwill and Almond to this special issue). For example, critical thinking errors, a reliance on false stereotypes, and the influence of schemas can influence judicial decisions (e.g. Stromwall & Granhag, 2003; Vrij, 2000, 2004; Vrij & Mann, 2004). Evaluations of truthfulness, specifically in forensic settings, may be flawed due to human biases, sometimes leading directly to wrongful decisions of culpability. Dangerous decisions theory (DDT; Porter & ten Brinke, 2009) describes the ‘path’ of psychological processes leading to mistaken evaluations of honesty and ultimately leading to wrongful judicial outcomes. According to DDT, the reading of a suspect’s, witness’s, or defendant’s face and emotional expressions plays a powerful and enduring role in initiating a series of ‘dangerous’ decisions concerning honesty. To take a courtroom example: potent but often inaccurate intuitive judgments by jurors of a defendant’s general ‘trustworthiness’ occur rapidly upon seeing his/her face for the first time, with a substantial influence on the manner in which the credibility of subsequent information from and about the individual is interpreted (Bar, Neta, & Linz, 2006; Willis & Todorov, 2006). Despite the lack of validity associated with such intuitive assessments of trustworthiness (Porter, England, Juodis, & ten Brinke, 2008), they are encouraged by judges (see *R. v. Lifchus*, 1997; *R. v. Mervyn*, 2003; *R. v. Roble*, 2004; *R. v. S. (R.D.)*, 1997). Based on this immediate evaluation, ensuing inferences about his/her honesty will become progressively irrational, but seem subjectively rational according to the decision maker’s deception schemas and heuristics (including false notions such as the gaze aversion hypothesis). Such false ideas about liars’ behaviour can (subconsciously) buttress the initial impression of the subject’s perceived trustworthiness.

Although most decision makers likely are motivated in their efforts to decide on ‘truth’, high motivation can exacerbate the level of bias in decisions about credibility

leading to progressively irrational judgments about the defendant and possibly guilt presumption (Ask & Granhag, 2007; Meissner & Kassin, 2002). As mentioned, excessive motivation itself may be negatively associated with the accuracy of deception judgments (Porter, McCabe *et al.*, 2007). Over-zealousness, coupled with the complexity of spotting lies, may serve to increase the power of the initial perception of trustworthiness and facilitate tunnel vision. In a preliminary study of DDT using a mock jury paradigm, Porter, Gustaw, and ten Brinke (2009) presented participants with vignettes of the same crimes accompanied either by a photo of a defendant whose face previously had been rated (in a pilot study) as appearing highly trustworthy or untrustworthy. It was found that participants required less evidence before finding an untrustworthy defendant guilty of murder. When presented with major exonerating evidence (DNA implicating someone else), participants changed their verdict to not guilty 84% of the time for trustworthy-looking defendants but only 42% of the time for untrustworthy-looking ones. Previous work had already established that baby-faced individuals receive more lenient judicial outcomes than mature-faced individuals and African American offenders with more Afrocentric facial features receive harsher sentences than those with fewer such features (Blair, Judd, & Chapleau, 2004; Zebrowitz & McDonald, 1991). Further, attractive defendants are more likely to be found not guilty, handed shorter sentences, and considered less dangerous than unattractive individuals (e.g. Bull & Rumsey, 1988; Downs & Lyons, 1991; Esses & Webster, 1988). Although our experiment did not address lying specifically and more ecologically valid research must follow (perhaps looking at wrongful conviction cases), instantaneous assessments of trustworthiness may play a major role in decisions of honesty and the assimilation of subsequent evidence about a subject. Simply put, certain faces are more credible than others regardless of actual honesty. Hopefully, but remaining to be seen, an awareness of such biases will reduce their negative impact on the detection of lies.

What works? Improving deception detection by attending to the best information

In facilitating the detection of high-stakes lies, the lie catcher must complement an avoidance of such pitfalls with a reliance on the most valid information available. In theory, 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 (Vrij, 2008a). The liar is forced to avoid betraying the deception by controlling feelings of guilt or excitement and monitoring his/her words to keep the story straight. While presenting enough detail to appear credible, the liar must avoid the provision of excessive information that could lead to problems recalling and maintaining the lie. While telling the tale, the liar must try to control facial expressions, and monitor body language. This necessary 'multi-tasking' should reduce the level of conscious control over each channel, and increase the amount of relative 'leakage' from one or the other(s), depending on to which he/she is devoting relative degrees of effort. In general, because liars have more on their mind than truth tellers, many opportunities arise for the unintentional communication of the deception. The prediction that patterns of behaviour tend to change from truth telling to lying has empirical support (e.g. Vrij & Mann, 2001b). Again, however, most deception studies have focused on lies that are trivial relative to those about crime or terrorism and more ecologically valid research is needed. Keeping this in mind, we turn to each of these channels that might assist in catching the motivated liar.

Non-verbal/body language indicators of deception

In theory, one should be closely attuned to changes in a subject's body language in assessing his/her honesty, attending to both voluntary and involuntary movements. The broad literature on deception substantiates that there are associations between body language and lying, although such relations generally are modest across studies. In their review, DePaulo *et al.* (2003) found that liars used fewer illustrators and pressed their lips together more frequently than truth tellers. They also found that stereotypical cues such as fidgeting and gaze aversion were unrelated to deception. Relative to other potential body language cues, the illustrator has both a theoretical foundation and empirical support. Motivated liars may be highly aware of the importance of controlling their body language in appearing credible and over-control voluntary movements. Liars may appear more rigid than usual, showing a reduction in hand and arm movements in trying to appear calm. Further, the cognitive complexity associated with high-stakes deception may result in a neglect of one's natural communicative style via body language, decreasing the use of illustrators.

Despite the potential utility of the illustrator, the reduction in arm movements associated with low-stakes, student produced deception does not appear to translate smoothly to high-stakes lies by criminal or other skilled deceivers. Only three studies in DePaulo *et al.*'s review examined forensic samples and the few studies focusing on non-verbal deceptive behaviour by offenders in low-stakes scenarios find different patterns to those witnessed in non-offenders. Klaver, Lee, and Hart (2007) found that offenders did not show a reduction in illustrator use when lying about a video they had viewed, contradicting the typical pattern in non-offenders. Porter, Doucette, Earle, and MacNeil (2008) found that offenders, unlike students, showed an increase in self-manipulations/adaptors (e.g. touching their heads) when lying about personal experiences. We have discussed previously the anecdotal cases of Saddam Hussein and Bill Clinton during high-stakes lies (accompanied by a decrease and increase in illustrator use, respectively). Thus, despite the complex pattern of results, it is reasonable to associate major *departures from baseline* (whether an increase or decrease) illustrator use with likely deception.

Ground-breaking studies by Vrij and colleagues were the first and only to code the non-verbal behaviour of criminal deceivers during high-stakes lying. Vrij and Mann (2001b) studied a murderer's behaviour during his police interview prior to and during his confession. When lying, he engaged in longer pauses, spoke more slowly, and made more non-ah speech disturbances. Next, Mann *et al.* (2002) examined videos of police interviews with sixteen diverse suspects whose crimes ranged from theft to murder. Similar to the case study findings, they engaged in longer pauses and blinked less when lying. As such, we can tentatively conclude that a lie catcher should be highly attuned to notable pauses during high-stakes narratives, again relative to baseline communication style.

In addition to exhibiting changes in voluntary movements, liars may communicate their hidden knowledge subconsciously through involuntary 'positive' signs in their body language. For example, Ekman (1992) observed a student subtly and unknowingly giving 'the finger' to a confederate professor who was berating her. We have observed other notable examples - even possible unconscious crime re-enactment by guilty, deceptive suspects - in working on various police cases. Although, we believe that the unconscious communication of covert information is potentially valuable to the lie catcher, its manifestations are difficult to test empirically given that such actions are

idiosyncratic and closely tied to context, depending on the nature of the concealed information or feelings about the offence or interviewer. Further, the lie catcher must be careful not to misinterpret 'meaningless' movements and commit false positive errors. In our view, such behavioural signs are extremely useful in generating hypotheses and directing lines of questioning.

The deceptive face: Identifying involuntary communication of concealed emotions

The face is a dynamic canvas on which emotions and intentions are communicated, and is scrutinized during all social interactions (Martelli, Majib, & Pelli, 2005). Considered a valuable gauge of credibility in legal settings, facial expressions can play a powerful role in leading to (often mistaken) inferences about honesty. Despite its frequent misinterpretation, the face has the great potential to communicate a liar's covert psychological state in subtle but perceptible ways to the trained lie catcher's benefit. Liars frequently must facilitate their deceit by altering their expressions through *simulating* (expressing an unfeared emotion), *masking* (replacing a felt expression with a false one), or *neutralizing* (inhibiting a true emotion by appearing neutral) an emotion (Ekman & Friesen, 1975). This can be particularly true for high-stakes lies. Perpetrators like White, for example, must mask their genuine feelings of anger, disgust, and/or guilt with false expressions of distress concerning the missing victim's welfare. Facial expressions potentially are of great relevance in betraying motivated lies because of the difficulty of faking genuine emotions and the involuntary nature of the expression of powerful concealed ones.

The idea that the deceptive face may communicate hidden emotions was first studied in the 19th century by Duchenne (1862/1990) who examined the muscle actions of the smile. He noted that the common notion of a happiness expression is the contraction of the *zygomatic major* muscle which upturns the mouth corners into a smile. But when this muscle was stimulated electrically, the resulting expression did not seem 'genuine'. As it turned out, the expression of felt happiness also involves the *orbicularis oculi* around the eye which pulls the cheek up while slightly lowering the brow (later established by Ekman and colleagues; e.g. Ekman, Davidson, & Friesen, 1990). Darwin (1872, p. 79) later noted: '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'. He proposed that some facial actions associated with strong emotion cannot be inhibited voluntarily. Further, he suggested that the same muscle actions cannot be engaged voluntarily during emotional simulation. Collectively, these propositions form the *inhibition hypothesis* (Ekman, 2003) which, although widely-assumed, was not directly examined until recently.

As mentioned, Porter and ten Brinke (2008) investigated the nature of facial expressions accompanying four types of falsified or concealed universal emotions: happiness, sadness, fear, and disgust for the first time. Participants viewed powerful emotional images, responding with a genuine or convincing but false expression while being judged by a naïve observer. The 697-videotaped expressions then were analyzed (each 1/30th seconds frame for more than 100,000 frames) by coders blind to expression veracity. The findings lent credibility to aspects of both Darwin's and Ekman's ideas but challenged others. 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, much longer than traditionally hypothesized. Further, participants were less successful at false displays of negative emotions than adopting a false 'happy face', a potentially important finding for forensic settings. Previous studies also have found differences in the duration, onset, and offset times between genuine and false expressions of happiness and disgust (e.g. Frank, Ekman, & Friesen, 2005; Hess & Kleck, 1990). Despite the salient presence of leakage in false expressions, naïve judges were able to discriminate genuine and deceptive expressions at a level only slightly above chance.

Collectively, these preliminary results suggested that knowledge of facial expressions could represent a potentially valuable tool in helping to identify falsified emotions in liars, particularly if the lie catcher has the luxury of a video review. The face clearly harbours covert information and its further study could improve deception detection practice in forensic settings. While our research was not on high-stakes deception, we hypothesize that even skilled liars may not be able to completely suppress emotional leakage in the face given its involuntary elements and potential for subconscious communication (see Dimberg, Thunberg, & Elmehed, 2000). However, while attention to facial expressions has the potential to unmask false emotion, it can never reveal the source of the leaked emotion. A fleeting expression of fear on a suspect's face, for example, could represent fear of being found out or a fear of being falsely implicated. Following the identification of a falsified emotion with appropriate questioning is essential (Ekman, 2006).

A better understanding of the relevance of the face in catching liars requires more ecologically valid studies of high-stakes lies and criminal offenders, including psychopaths who have a profound emotional deficit (see Patrick, 2006). While such studies are not easy practically or methodologically, they can be done as Vrij and colleagues have demonstrated. We currently are collecting and analyzing videos (about 60 so far) from around the world in which relatives publicly plead for the return of their missing loved ones. By selecting cases in which the fate of the missing person has been established with certainty (e.g. DNA evidence), we have been able to categorize honest individuals versus deceptive killers. We hypothesize that emotional expressions (coded by a 'blind' analyst) will be difficult for liars to control in such an extremely high-stakes setting. Eventually, we hope to devise a 'sincerity index' of expressions which, with validation, could serve as a guide to credibility assessment with similar high-stakes emotional liars. We encourage deception researchers to develop innovative approaches to studying this long-recognized but under-studied approach to identifying high-stakes lies.

Identifying verbal signs of deception: A fusion of science and psychological insight

Because lies in forensic contexts typically involve the production of verbal statements, researchers long have been interested in the qualities of deceptive narratives and their manner of delivery. 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).

First, linguistic patterns can help in differentiating liars and truth-tellers. The broad deception literature suggests that, relative to truth-tellers, unprepared liars tend to take longer to begin their responses while prepared liars exhibit a shorter response latency. Further, liars are more likely than truth-tellers to repeat words, phrases, and details (DePaulo *et al.*, 2003; Porter, Yuille, & Lehman, 1999; Sporer & Schwandt, 2006).

In addition, the relatively recent development of computerized linguistic software (linguistic inquiry and word count (LIWC); Pennebaker, Francis, & Booth, 2001) has established cues to dishonest speech, presumably beyond volitional control. 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). 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 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 results in analyzing the statements of incarcerated offenders telling lies about a video they had recently watched (still low-stakes deception). Although this linguistic approach is promising, research with forensic samples and high-stakes lies is necessary to establish the utility of linguistics as an applied deception detection tool.

Secondly, much empirical attention has focused on qualitative aspects of details in deceptive versus truthful narratives. To elaborate, we focus on the research on criteria-based content analysis (CBCA), the most widely studied statement analysis approach, complemented by anecdotal observations. CBCA is based on the 'Undeutsch hypothesis', positing that accounts based on memory for an experienced event differ qualitatively and quantitatively from fictitious reports (Undeutsch, 1967). This approach requires an analysis of nineteen 'reality criteria' in a statement with complementary consideration of a validity checklist concerning individual characteristics, witness motivations, and the presence of other evidence (see Vrij, 2008a). Research on CBCA establishes that deceptive stories typically receive lower CBCA scores than truthful ones; 80% of field and experimental studies reviewed by Vrij (2008a) found that more criteria occur in genuine versus fabricated descriptions. However, some criteria have received more support than others; quantity of details, unstructured production, contextual embedding, and reproduction of conversation have been supported in at least 50% of relevant studies. In contrast, related external associations, self-deprecation, and pardoning the perpetrator received support in fewer than 20% of relevant studies. The interpretation of CBCA results therefore must be 'global' in which the overall pattern of scores is considered and the presence of individual criteria should not form the basis of a credibility decision.

In our view, some limitations of CBCA include its susceptibility to 'coaching' (Vrij, Kneller, & Mann, 2000), the subjectivity of the final determination of credibility in the absence of a formal weighting system, the problematic validity of several criteria, and an absence of a theoretical foundation for each criterion. Further, there has been insufficient research on the statements of high-stakes deceivers for whom ground truth is known (i.e. true and false stories concerning crime). The promise in CBCA lies in the consistent validity of several of the criteria mentioned above in catching liars and the development of a standardized weighting system for the criteria which could serve to increase its accuracy and sensitivity. Further, novel and valid criteria could be added while existing, unsupported criteria should be eradicated. Another issue for researchers to consider, relating to the coaching/knowledge issue, is that most research on CBCA has been conducted on amateur deceivers. In considering cases of serious crime, skill and practice - perhaps even training in the case of terrorists - with lying will almost certainly influence the quality of deceptive narratives. The influence of such conscious strategies and generalized deception skill on CBCA results requires empirical attention. However, the huge amount of thought and research devoted to CBCA strongly support

its current use as an effective deception detection tool, so long as the evaluator has knowledge of its proper manner of interpretation.

Complementing formalized statement analysis is the recognition that liars sometimes betray themselves through language in idiosyncratic ways that are difficult to study empirically but are identifiable to a keen observer. We can refer to such unintentional subjective slips as 'verbal leakage'. For example, in some missing person cases, the perpetrator relative has referred to the missing person in the past tense. Before his wife's body was found, Scott Peterson referred to her 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 polygrapher Avinoam Sapir and used widely by investigators around the world. Despite its face validity and the credibility widely granted to SCAN by investigators, ecologically valid research is sorely needed to confirm its validity (which is brought into question by a few lab-based studies; e.g. Porter & Yuille, 1996; Smith, 2001). Another speech idiosyncrasy, relating to deception by omission, involves important details that are strategically omitted by the liar in a narrative. In a murder case on which the authors were consulted, the suspect admitted to a vaguely defined argument 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 an ostensibly credible report. Thus, complementing standardized, empirically validated approaches such as CBCA, close attention to such narrative idiosyncrasies can be useful; this strategy supplements an empirically driven decision about honesty and can lead to effective lines of questioning. In general, we - like Vrij (2008) - think that verbal cues represent one of the key considerations in catching high-stakes liars.

Integrative approaches

While research has highlighted some potentially valuable non-verbal, facial, and verbal cues to deception, the influence of contextual and individual difference variables must be kept in mind by the lie catcher. 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. While we agree with this contention in part, we believe that both facial and non-verbal cues can assist the *informed* investigator. And further it must be recognized that, despite its prominence in the theoretical literature and popular science, the face is largely uncharted territory in the deception area from an empirical perspective. It could offer an extremely important avenue for catching liars with further research and validation. Porter *et al.* (2000) demonstrated that a holistic approach addressing deception myths, dispelling notions 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 (from 40.4% at baseline to 76.7% accuracy) over two days of intensive training. More recently, only 2 hours of this type of (updated) training was successful in producing a modest (12% change), but statistically significant, increase in participants' ability to detect deception in videotaped narratives.

While the presence of a single behavioural cue may not provide convincing 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. In situations that allow, the validity of such a multi-cue approach might be bolstered by the baseline method. We suggest that if the lie catcher has the benefit of sound knowledge of a target's baseline truthful behaviour (ideally videotaped along with the potential deception) and observes a consistent change in illustrator use, pause length, speech rate and/or other behaviours, it may be evidence for deception to be considered along with other information. In an interview context, such behaviour should arouse suspicion and lead to focused questioning. One caveat to the baseline method is that a *comparable* baseline is necessary. A change in setting, subject matter or stakes during an interview, to name a few factors, may also lead to behavioural changes that should not necessarily be attributed to deception. As such, the interviewer would be wise to inquire about comparable truthful events for which ground truth is known before (and perhaps after) the crime or key event is discussed. This can be a challenge but is not impossible and will depend on the target and type of crime. Questions about past crimes and known traumatic experiences (death of a loved one) are examples of inquiries that could be used to establish baseline non-verbal behavioural patterns.

Moving forward: New issues and the future of deception research cyber deception

Ever-advancing technology has introduced new channels through which interpersonal deception occurs and new tools for its detection. As on-line communication becomes a progressively pervasive aspect of life, cyber deception inevitably has increased. Deception is extremely common in e-mail, instant messaging, chatrooms, and on-line dating sites (Hancock, 2007; Hancock, Thom-Santelli, & Ritchie, 2004; Toma, Hancock, & Ellison, 2008; Whitty, 2002; Whitty & Carville, 2008), and extends to major cyber crime such as fraud and child exploitation on a massive scale. By examining linguistic markers, researchers are beginning to understand deceptive behaviour in cyberspace interactions. For example, during instant messaging deceivers tend to be more 'involved' in the conversation than truth-tellers, initiating conversations more often, writing longer messages, and taking shorter breaks between sent messages, while distancing themselves from the lie by using fewer self-oriented pronouns (e.g. Hancock, Curry, Goorha, & Woodworth, 2008; Zhou, 2005). This line of linguistic research, although in its infancy, has much potential social relevance. From a forensic perspective, the study of internet communications by criminal offenders is essential.

Active interviewing strategies for detecting lies

While traditional deception research typically has focused on detection accuracy in 'passive' tasks such as judging videotaped speakers, recent work has been addressing the utility of 'strategic', active interviewing approaches. While it is beyond the scope of this paper to explore investigative interviewing in a detailed way, we will highlight a few examples. One novel approach in which deceivers' cognitive load is increased by asking them to recall the event in question in reverse-order (or introducing a secondary task) has been shown to exacerbate leakage in specific behavioural channels; reverse-order lies result in slower speech, more speech hesitations/errors, and less contextual embedding (Vrij, Mann, Fisher, Leal, Milne, & Bull, 2008). Even more encouraging is that

police officers were better at detecting deception among cognitively overloaded liars, achieving 58% accuracy without additional training. Another promising approach, involves the strategic use of evidence. Using a simple multiple choice questionnaire that asks denying suspects to provide – even guess if necessary – their knowledge of crime details, guilty suspects are likely to minimize their knowledge of the crime to the extent that they respond *below* the level of chance while innocent individuals would be expected to respond *at* chance (Porter, Stewart, & Campbell, 2007; see also the contribution by van Oorsouw & Merckelbach to this special issue). In a different way, the strategic use of evidence (SUE) technique, capitalizes on the guilty individual's knowledge of the crime by asking specific-questions regarding incriminating details without revealing evidence known to the interviewer. In this way, deceivers are challenged to provide a believable answer while being careful not to leak incriminating evidence nor contradict evidence that investigators may have learned. In addition to increasing cognitive load for liars, guilty suspects are more likely to contradict the evidence relative to innocent individuals who generally adopt a 'tell it like it happened' strategy (Granhag & Hartwig, 2008; Stromwall, Hartwig, & Granhag, 2006). Importantly, when police officers were so trained, they were able to detect deception in mock crime suspects with 85.4% accuracy compared to 56.1% by untrained officers (Hartwig, Granhag, Stromwall, & Kronkvist, 2006). Inconsistencies also can be examined in the information provided by pairs of deceivers interviewed separately. A recent study by Vrij *et al.* (2009) highlighted the benefit of asking unanticipated questions. Comparing accomplice responses to unconventional requests, including producing an illustration of the scene in question, resulted in the greatest discriminatory success. By examining responses from deceptive accomplices, inconsistent answers classified up to 80% of liars and truth-tellers correctly. With further validation, the implementation of such active strategies has the potential to increase behavioural leakage and the detection of lies in forensic interviews.

Towards the truth: Putting it all together

We have discussed our current understanding of high-stakes deceptive behaviour, noting clear potentials in the field and acknowledging limitations in current knowledge. Based on this review, we offer some recommendations for deception detection research and practice. Most importantly for the future of deception detection research, there is a great need to examine forensic populations and high-stakes lies. Further research on the utility of behavioural cues in real police interviews, and the development of additional creative ways to actively influence liars' behaviour are the next important steps in this line of study. As researchers continue to search for the most effective means of detecting deception, we must exercise caution when putting new techniques into practice. Despite the excitement that sometimes surrounds the latest findings and technologies, we should learn from our past mistakes and follow empirical evidence rather than blind enthusiasm.

Until further research on high-stakes lies is conducted, our three primary recommendations for lie catchers include: (1) the need for education in the major pitfalls to avoid in catching lies and acknowledging the importance of critical thinking to circumvent tunnel vision associated with overzealousness. Such educational training may take the form of didactic empirically supported training sessions/workshops in deception detection, autodidactic approaches wherein lie detectors are encouraged to keep up with the latest deception literature independently, and critical discussions between colleagues to share the challenges and successes associated with specific cases; (2) armed with the

latest empirical knowledge of deceptive behaviour, the lie catcher should direct his/her attention to prominent and ideally consistent changes from baseline behaviour with a focus on the most reliable specific cues to deception. While a perfectly reliable cue to deception likely does not exist, the combination of attention to changes in non-verbal/body language, verbal, and facial channels – ideally videotaped – can provide the basis for an informed opinion about credibility, backed by other evidence. Specific cues with the strongest support to date include illustrators (a major increase or decrease), reduced blink rate, increased response latency, longer and more frequent pauses, reduced speech rate, vague descriptions, repeated details, overly structured productions, a lack of contextual embedding, and a lack of reproduced conversation concerning incidents involving multiple persons (i.e. most serious crimes). Further, the lie catcher should be highly attuned to idiosyncratic ‘slips’ – including verbal (such as tense changes; e.g. suspect in a missing persons case refers to the missing individual in the past tense) non-verbal (such as unconscious communications to the interviewer including potential crime re-enactments), and facial cues (involuntary fleeting emotional expressions typically occurring in the upper or lower face only and false expressions more generally), and (3) depending on the context, the lie detector also should consider the use of strategic interviewing techniques such as manipulating a suspect’s cognitive load, asking unanticipated questions, assessing response accuracy on guilty-knowledge questionnaires, and the strategic use of evidence to direct questioning and detect deception.

Together, the application of such strategies will assist in the identification of high-stakes liars and improve legal decision-making more generally.

Acknowledgements

The authors would like to acknowledge the Social Sciences and Humanities Research Council of Canada (SSHRC) and the National Sciences and Engineering Research Council of Canada (NSERC) who provided funding for the preparation of this article through grants awarded to the first author. We would further like to acknowledge the support of NSERC and Killam Trusts through graduate scholarships awarded to the second author.

References

- Ask, K., & Granhag, P. A. (2007). Motivational bias in criminal investigators’ judgments of witness reliability. *Journal of Applied Social Psychology, 37*, 561–591.
- Bar, M., Neta, M., & Linz, H. (2006). Very first impressions. *Emotion, 6*, 269–278.
- Ben-Shakhar, G. (2008). The case against the use of polygraph examinations to monitor postconviction sex offenders. *Legal and Criminological Psychology, 13*, 191–207.
- Blair, I. V., Judd, C. M., & Chapleau, K. M. (2004). The influence of afrocentric facial features in criminal sentencing. *Psychological Science, 15*, 674–679.
- Blair, J. P., & Kooi, B. (2004). The gap between training and research in the detection of deception. *International Journal of Police Science and Management, 6*, 77–83.
- Bond, C. F., Jr, & Uysal, A. (2007). On lie detection ‘wizards’. *Law and Human Behavior, 31*, 109–115.
- Bond, G. D., & Lee, A. Y. (2005). Language of lies in prison: Linguistic classification of inmates’ truthful and deceptive natural language. *Applied Cognitive Psychology, 19*, 313–329.
- Bull, R., & Rumsey, N. (1988). *The social psychology of facial appearance*. New York: Springer-Verlag Publishing.
- Costanzo, M., Gerrity, E., & Lykes, M. B. (2007). Psychologists and the use of torture in interrogations. *Analysis of Social Issues and Public Policy, 7*, 7–20.
- Darwin, C. (1965/1872). *The expression of the emotions in man and animals*. Chicago: University of Chicago.

- Davis, M., & Hadiks, D. (1995). Demeanor and credibility. *Semiotica*, *106*, 5–54.
- DePaulo, B. M., Kashy, D. A., Kirkendol, S. E., Wyer, M. M., & Epstein, J. A. (1996). Lying in everyday life. *Journal of Personality and Social Psychology*, *70*, 979–995.
- DePaulo, B. M., & Kirkendol, S. E. (1989). The motivational impairment effect in the communication of deception. In J. C. Yuille (Ed.), *Credibility assessment* (pp. 51–70). Dordrecht, The Netherlands: Kluwer.
- DePaulo, B. M., Lindsay, J. J., Malone, B. E., Muhlenbruck, L., Charlton, K., & Cooper, H. (2003). Cues to deception. *Psychological Bulletin*, *129*, 74–118.
- Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science*, *11*, 86–89.
- Downs, A. C., & Lyons, P. M. (1991). Natural observations of the links between attractiveness and initial legal judgments. *Personality and Social Psychology Bulletin*, *17*, 541–547.
- Duchenne, G. B. (1990/1862). *The mechanism of human facial expression*. New York: Cambridge University Press.
- Ekman, P. (1992). *Telling lies: Clues to deceit in the marketplace, politics, and marriage*. New York: W. W. Norton.
- Ekman, P. (2003). Darwin, deception and facial expression. In P. Ekman, R. J. Davidson, & F. De Waals (Eds.), *Annals of the New York Academy of Sciences* (Vol. 1000, pp. 205–221). New York: New York Academy of Sciences.
- Ekman, P. (2006, October 29). *How to spot a terrorist on the fly*. Retrieved November 17, 2008, from [washingtonpost.com](http://www.washingtonpost.com)
- Ekman, P., Davidson, R. J., & Friesen, W. V. (1990). The Duchenne smile: Emotional expression and brain physiology: II. *Journal of Personality and Social Psychology*, *58*, 342–353.
- Ekman, P., & Friesen, W. V. (1975). *Unmasking the face: A guide to recognizing emotions from facial clues*. Upper Saddle River, NJ: Prentice-Hall.
- Ekman, P., & O'Sullivan, M. (1991). Who can catch a liar? *American Psychologist*, *46*, 913–920.
- Ekman, P., O'Sullivan, M., & Frank, M. (1999). A few can catch a liar. *Psychological Science*, *10*, 263–266.
- Elaad, E., Ginton, A., & Ben-Shakhar, G. (1994). Detection measures in real-life criminal guilty knowledge tests. *Journal of Applied Psychology*, *77*, 757–767.
- Esses, V. M., & Webster, C. D. (1988). Physical attractiveness, dangerousness, and the Canadian criminal code. *Journal of Applied Social Psychology*, *18*, 1017–1031.
- Frank, M. G., Ekman, P., & Friesen, W. V. (2005). Behavioral markers and recognizability of the smile of enjoyment. In P. Ekman & E. L. Rosenberg (Eds.), *What the face reveals* (2nd ed., pp. 217–238). New York: Oxford University Press.
- Gamer, M., Rill, H.-G., Vossel, G., & Godert, H. W. (2006). Psychophysiological and vocal measures in the detection of guilty knowledge. *International Journal of Psychophysiology*, *60*, 76–87.
- Giridharadas, A. (2008). *India uses new brain scanner to convict*. Retrieved September 19, 2008, from www.nytimes.com
- Granhag, P. A., Andersson, L. O., Strömwall, L. A., & Hartwig, M. (2004). Imprisoned knowledge: Criminal beliefs about deception. *Legal and Criminological Psychology*, *9*, 103–119.
- Granhag, P. A., & Hartwig, M. (2008). A new theoretical perspective on deception detection: On the psychology of instrumental mind-reading. *Psychology, Crime and Law*, *14*, 189–200.
- Granhag, P. A., & Strömwall, L. A. (2004). Research on deception detection: Intersections and future challenges. In P. A. Granhag & L. A. Strömwall (Eds.), *The deception of detection in forensic contexts* (pp. 317–330). Cambridge: Cambridge University Press.
- Greely, H., & Illes, J. (2007). Neuroscience-based lie detection: The urgent need for regulation. *American Journal of Law and Medicine*, *33*, 377–431.
- Hancock, J. (2007). Digital Deception: When, where, and how people lie online. In K. McKenna, T. Postmes, U. Reips, & A. Joinson (Eds.), *Oxford handbook of internet psychology* (pp. 287–301). Oxford: Oxford University Press.

- Hancock, J., Thom-Santelli, J., & Ritchie, T. (2004). Deception and design: The impact of communication technology on lying behavior. In *Proceedings of CHI 2004* (pp. 129-134). New York: ACM Press.
- Hancock, J. T., Curry, L., Goorha, S., & Woodworth, M. T. (2008). On lying and being lied to: A linguistic analysis of deception. *Discourse Processes, 45*, 1-23.
- Hartwig, M., Granhag, P. A., Stromwall, L. A., & Andersson, L. O. (2004). Suspicious minds: Criminals' ability to detect deception. *Psychology, Crime and Law, 10*, 83-94.
- Hartwig, M., Granhag, P. A., Stromwall, L. A., & Kronkvist, O. (2006). Strategic use of evidence during police interviews: When training to detect deception works. *Law and Human Behavior, 30*, 603-619.
- Hess, U., & Kleck, R. E. (1990). Differentiating emotional elicited and deliberate emotional facial expressions. *European Journal of Social Psychology, 20*, 369-385.
- Honts, C. R. (2004). The physiological detection of deception. In P. A. Granhag & L. A. Stromwall (Eds.), *Deception detection in forensic contexts* (pp. 103-123). Cambridge: Cambridge Press.
- Iacono, W. G. (2008). Effective policing: Understanding how polygraph test work and are used. *Criminal Justice and Behavior, 35*, 1295-1308.
- John E. Reid & Associates, Inc. (2004). *Interviewing and Interrogation*. Retrieved January 7, 2009, from http://www.reid.com/training_programs/interview_overview.html
- Kahneman, D., & Tversky, A. (1982). The psychology of preferences. *Scientific American, 246*, 160-173.
- Kassin, S. (2005). On the psychology of confessions: Does innocence put innocents at risk? *The American Psychologist, 60*, 215-228.
- Kassin, S. (2008). Confession evidence: Commonsense myths and misconceptions. *Criminal Justice and Behavior, 35*, 1309-1322.
- Kassin, S. M., & Fong, C. T. (1999). 'I'm Innocent!': Effects of training on judgments of truth and deception in the interrogation room. *Law and Human Behavior, 23*, 499-516.
- Klaver, J., Lee, Z., & Hart, S. D. (2007). Psychopathy and nonverbal indicators of deception in offenders. *Law and Human Behavior, 31*, 337-351.
- Langleben, D. D. (2008). Detection of deception with fMRI: Are we there yet? *Legal and Criminological Psychology, 13*, 1-9.
- Langleben, D. D., Schroeder, L., Maldjian, J. A., Gur, R. C., McDonald, S., Ragland, J. D., et al. (2002). Brain activity during simulated deception: An event-related functional magnetic resonance study. *Neuroimage, 15*, 727-732.
- Livingstone Smith, D. (2004). *Why we lie: The evolutionary roots of deception and the unconscious mind*. New York: St Martin's Press.
- MacLaren, V. V. (2001). A quantitative review of the guilty knowledge test. *Journal of Applied Psychology, 86*, 674-683.
- Mann, S., Vrij, A., & Bull, R. (2002). Suspects, lies and videotape: An analysis of authentic high-stakes liars. *Law and Human Behavior, 26*, 365-376.
- Mann, S., Vrij, A., & Bull, R. (2004). Detecting true lies: Police officers' ability to detect deceit. *Journal of Applied Psychology, 89*, 137-149.
- Martelli, M., Majib, J. M., & Pelli, D. G. (2005). Are faces processed like words? A diagnostic test for recognition by parts. *Journal of Vision, 5*, 58-70.
- Meissner, C. A., & Kassin, S. M. (2002). 'He's guilty!': Investigator bias in judgments of truth and deception. *Law and Human Behavior, 26*, 469-480.
- Newman, M. L., Pennebaker, J. W., Berry, D. S., & Richards, J. M. (2003). Lying words: Predicting deception from linguistic style. *Personality and Social Psychology Bulletin, 29*, 665-675.
- O'Sullivan, M., & Ekman, P. (2004). The wizards of deception detection. In P. A. Granhag & L. A. Stromwall (Eds.), *Deception detection in forensic contexts* (pp. 269-286). Cambridge, UK: Cambridge Press.
- Patrick, C. J. (2006). *Handbook of psychopathy*. New York: Guilford Press.
- Pennebaker, J. W., Francis, M. E., & Booth, R. J. (2001). *Linguistic inquiry and word count (LIWC): LIWC 2001*. Mahwah, NJ: Erlbaum.

- Porter, S., Doucette, N., Earle, J., & MacNeil, B. (2008). 'Halfe the world knowes not how the other halfe lies': Investigation of cues to deception exhibited by criminal offenders and non-offenders. *Legal and Criminological Psychology, 13*, 27-38.
- Porter, S., England, L., Juodis, M., ten Brinke, L., & Wilson, K. (2008). Is the face the window to the soul?: Investigation of the accuracy of intuitive judgments of the trustworthiness of human faces. *Canadian Journal of Behavioural Science, 40*, 171-177.
- Porter, S., Gustaw, C., & ten Brinke, L. (in press). Dangerous decisions: The impact of first impressions of trustworthiness on the evaluation of legal evidence and defendant culpability. *Psychology Crime & Law*.
- Porter, S., McCabe, S., Woodworth, M., & Peace, K. A. (2007). Genius is 1% inspiration and 99% perspiration? . . . or is it? An investigation of the effects of motivation and feedback on deception detection. *Legal and Criminological Psychology, 12*, 297-309.
- Porter, S., Stewart, C., & Campbell, M. A. (2007). To the best of my knowledge officer: Investigation of crime questionnaire patterns associated with guilty knowledge concealment. *The Canadian Journal of Police and Security Services, 5*, 1-8.
- Porter, S., & ten Brinke, L. (2008). Reading between the lies: Identifying concealed and falsified emotions in universal facial expressions. *Psychological Science, 19*, 508-514.
- Porter, S., & ten Brinke, L. (2009). Dangerous decisions: A theoretical framework for understanding how judges assess credibility in the courtroom. *Legal and Criminological Psychology, 14*, 119-134.
- Porter, S., ten Brinke, L., & Wilson, K. (2009). Crime profiles and conditional release performance of psychopathic and non-psychopathic sexual offenders. *Legal and Criminological Psychology, 14*, 109-118.
- Porter, S., & Woodworth, M. (2007). I'm sorry I did it . . . but he started it: A comparison of the official and self-reported homicide descriptions of psychopath and non-psychopaths. *Law and Human Behavior, 31*, 91-107.
- Porter, S., Woodworth, M., & Birt, A. R. (2000). Truth, lies, and videotape: An investigation of the ability of federal parole officers to detect deception. *Law and Human Behavior, 24*, 643-658.
- Porter, S., & Yuille, J. C. (1995). Credibility assessment of criminal suspects through statement analysis. *Psychology, Crime, and Law, 1*, 319-331.
- Porter, S., & Yuille, J. C. (1996). The language of deceit: An investigation of the verbal clues to deception in the interrogation context. *Law and Human Behavior, 20*, 443-458.
- Porter, S., Yuille, J. C., & Lehman, D. (1999). The nature of real, implanted, and fabricated memories for emotional childhood events: Implications for the recovered memory debate. *Law and Human Behavior, 23*, 517-538.
- R. v. B. (K. G.), [1993] 1 S.C.R. 740.
- R. v. Marquard, [1993] 4 S.C.R. 223.
- R. v. Lifchus, [1997] 3 S.C.R. 320.
- R. v. S. (R. D.) (1997) 3 S.C.R.
- R. v. Mervyn, [2003] Y.K.T.C. 34.
- R. v. Roble, [2004] CanLII 23106 (ON C.A.).
- Rosenfeld, J. P. (2005). 'Brain Fingerprinting': A Critical Analysis. *Scientific Review of Mental Health Practice, 4*, 20-37.
- Ryan, H. (September 22, 2004). *Jurors watch TV interviews revealing Scott Peterson's litany of lies*. Retrieved November 17, 2008, from courttv.com
- Smith, N. (2001). *Reading between the lines: An evaluation of the scientific content analysis technique (SCAN)*. Police research series paper 135. London: UK Home Office, Research, Development and Statistics Directorate.
- Spence, S. A. (2008). Playing Devil's advocate: The case against fMRI lie detection. *Legal and Criminological Psychology, 13*, 11-25.
- Spence, S. A., Hunter, M. D., Farrow, T. F. D., Green, R. D., Leung, D. H., Hughes, C. J., et al. (2004). A cognitive neurobiological account of deception: Evidence from functional neuroimaging. *Philosophical Transactions of the Royal Society B: Biological Sciences, 359*, 1755-1762.

- Sporer, S. L., & Schwandt, B. (2006). Paraverbal indicators of deception: A meta-analytic synthesis. *Applied Cognitive Psychology, 20*, 421–446.
- Stix, G. (August 13, 2008) *Can fMRI really tell if you're lying?* Retrieved November 12, 2008, from www.sciam.com
- Strömwall, L. A., & Granhag, P. A. (2003). How to detect deception? Arresting the beliefs of police officers, prosecutors and judges. *Psychology, Crime and Law, 9*, 19–36.
- Strömwall, L. A., Hartwig, M., & Granhag, P. A. (2006). To act truthfully: Nonverbal behavior and strategies during a police interrogation. *Psychology, Crime and Law, 12*, 207–219.
- The Canadian Press (December 13, 2006). *Convicted wife-killer asks mother-in-law to raise daughter.* Retrieved November 12, 2008, from cbc.ca
- Toma, C., Hancock, J., & Ellison, N. (2008). Separating fact from fiction: An examination of deceptive self-presentation in online dating profiles. *Personality and Social Psychology Bulletin, 34*, 1023–1036.
- Undeutsch, U. (1967). Beurteilung der Glaubhaftigkeit von Aussagen. In U. Undeutsch (Ed.), *Handbuch der Psychologie Vol. 11: Forensische Psychologie* (pp. 26–181). Gottingen: Hogrefe.
- Vrij, A. (2000). *Detecting lies and deceit: The psychology of lying and the implications for professional practice.* Chichester: Wiley.
- Vrij, A. (2004). Why professionals fail to catch liars and how they can improve. *Legal and Criminological Psychology, 9*, 159–181.
- Vrij, A. (2008a). *Detecting lies and deceit: Pitfalls and opportunities.* Chichester: Wiley.
- Vrij, A. (2008b). Non-verbal dominance versus verbal accuracy in lie detection: A plea to change police practice. *Criminal Justice and Behavior, 35*, 1323–1336.
- Vrij, A., Kneller, W., & Mann, S. (2000). The effect of informing liars about criteria based content analysis on their ability to deceive CBCA-raters. *Legal and Criminological Psychology, 5*, 57–70.
- Vrij, A., Leal, S., Granhag, P. A., Mann, S., Fisher, R. P., Hillman, J., et al. (2009). Outsmarting the liars: The benefit of asking unanticipated questions. *Law and Human Behavior, 33*, 159–166.
- Vrij, A., & Mann, S. (2001a). Who killed my relative? Police officers' ability to detect real-life high-stake lies. *Psychology, Crime, and Law, 7*, 119–132.
- Vrij, A., & Mann, S. (2001b). Telling and detecting lies in a high-stake situation: The case of a convicted murderer. *Applied Cognitive Psychology, 15*, 187–203.
- Vrij, A., & Mann, S. (2004). Detecting deception: The benefit of looking at a combination of behavioral, auditory and speech content related cues in a systematic manner. *Group Decision and Negotiation, 13*, 61–79.
- Vrij, A., Mann, S., & Fisher, R. P. (2006). An empirical test of the behaviour analysis interview. *Law and Human Behavior, 30*, 329–345.
- Vrij, A., Mann, S., Fisher, R., Leal, S., Milne, B., & Bull, R. (2008). Increasing cognitive load to facilitate lie detection: The benefit of recalling an event in reverse order. *Law and Human Behavior, 32*, 253–265.
- Whitty, M. T. (2002). Liar, liar! An examination of how open supportive and honest people are in chat rooms. *Computers in Human Behavior, 18*, 343–352.
- Whitty, M. T., & Carville, S. E. (2008). Would I lie to you? Self-serving lies and other-oriented lies told across different media. *Computers in Human Behavior, 24*, 1021–1031.
- Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100 ms exposure to a face. *Psychological Science, 17*, 592–598.
- Wilson, P. J. (2003). Wrongful convictions: Lessons learned from the Soponow Public Inquiry. Canadian Police College.
- Wolpe, P. R., Foster, K. R., & Langleben, D. D. (2005). Emerging neurotechnologies for lie-detection: promises and perils. *American Journal of Bioethics, 5*, 39–49.
- Zebrowitz, L. A., & McDonald, S. (1991). The impact of litigants' babyfacedness and attractiveness on adjudications in small claims courts. *Law and Human Behavior, 15*, 603–623.
- Zhou, L. (2005). An empirical investigation of deception behavior in instant messaging. *IEEE Transactions on Professional Communication, 48*, 147–160.