

PSYCHOPATHY AND PHYSIOLOGICAL DETECTION OF CONCEALED INFORMATION: A REVIEW

Bruno VERSCHUERE, Geert CROMBEZ,
Ernst H.W. KOSTER, & Katarzyna UZIEBLO
Ghent University

The Concealed Information Test has been advocated as the preferred method for deception detection using the polygraph ("lie detector"). The Concealed Information Test is argued to be a standardised, highly accurate psychophysiological test founded on the orienting reflex. The validity of polygraph tests for the assessment of psychopathic individuals has, however, been questioned. Two dimensions are said to underlie psychopathy: emotional detachment and antisocial behaviour. Distinct psychophysiological correlates are hypothesised in these facets of psychopathy. Emotional detachment is associated with deficient fear-potentiated startle, and antisocial behaviour with reduced orienting. Few studies have examined the effect of psychopathy on the validity of the Concealed Information Test. This review suggests that reduced orienting in high antisocial individuals is also found in the Concealed Information Test, thereby threatening its validity. Implications for criminal investigations, possible solutions and directions for future research will be discussed.

Introduction

The polygraph ("lie detector") is a highly debated method for the detection of deception. The polygraph is an apparatus that allows accurate measurement of small changes in bodily reactions, such as skin conductance, respiration and cardiac activity. Several polygraph techniques have been developed, of which the Control Question Technique (CQT; Reid, 1947) and the Concealed Information Test (CIT; Lykken, 1957) are the most important. These techniques make use of the same physiological measures, but differ in the questions asked during the interrogation. In the Control Question Technique a comparison is made between crime ("Have you stolen the laptop?") and arousal-evoking control questions ("Have you ever told a lie to an authority figure?"). The polygraph examinee is supposed to show the greatest physiological responses to the questions that pose the largest threat. It is assumed that these involve the relevant questions for the guilty suspect, and

All authors are affiliated with the Department of Psychology, Ghent University. Bruno Verschuere is a postdoctoral fellow of the Fund for Scientific Research - Flanders, Belgium (FWO).

Correspondence concerning this paper can be sent to Bruno Verschuere, Department of Psychology, Ghent University, Henri Dunantlaan, 9000 Gent. E-mail: bruno.verschuere@ugent.be

the control questions for the innocent suspect (Honts, 1994). The plausibility of these assumptions has been questioned. Iacono and Lykken (1997; but see Honts, 2003) asked members of the Society of Psychophysiological Research and the American Psychological Association whether they “would say that the CQT is based on scientifically sound psychological principles or theory?” The survey showed that the majority would not. The ongoing scientific controversy has prevented court admissibility (Ben-Shakhar, Bar-Hillel, & Kremnitzer, 2002).

Interestingly, the survey of scientific opinion also revealed that most responders considered the Concealed Information Test to be scientifically sound. Laboratory research has indeed confirmed the validity of this polygraph technique (Ben-Shakhar & Elaad, 2003). Still, little is known on how the Concealed Information Test performs in real life settings. One reason of concern is the elevated rates of psychopathy in criminals compared to the general population (15-30% versus 1-5%; e.g., Harpur & Hare, 1994). Psychopaths are generally characterised as antisocial, emotionally blunted, deceptive, and unscrupulous. Thus, psychopaths may be expected to show reduced reactivity on polygraph tests. In this review we will discuss *why* (the theory) and *whether* (the empirical data) psychopathy has an effect on the validity of the Concealed Information Test.

The validity of the Concealed Information Test: accuracy & theory

The Concealed Information Test consists of a series of questions, each having one correct and several incorrect items. A typical demonstration of this method is the card test. Here, the participant is asked to choose a card from a deck of cards, numbered from 1 to 5. Then, the participant will be asked: “Did you pick...number one?...number two?...number three?...number four?...number five?”. Several studies have demonstrated that most participants will show an involuntarily bodily response to the chosen number (Ben-Shakhar & Elaad, 2003), with skin conductance being one of the most sensitive indices in this test (Ben-Shakhar & Furedy, 1990). In criminal investigations, the Concealed Information Test can be of use when someone is unwilling to share certain information. Most often, crime suspects will deny crime involvement. In such cases, a Concealed Information Test could be used to assess whether the suspect recognises secret crime information. In a robbery case, for example, one might question the suspect about how the robber escaped (“Do you know how the robbers got away? Was that...on foot?...by car?...by motorcycle?...by subway?...by bike?). Several questions of this kind could be formulated: about what was stolen, what specific clothes were worn by the victim, what kind of weapon the robber used, etc.

An innocent suspect does not know the answers to these questions and will therefore display similar bodily responses to all answers. The robber, on the other hand, knows that he got away by bike, that he stole the victim's laptop, that the victim wore a grey suit, and that he used a knife. The robber will recognise the correct answers, and will show a physiological response to them.

Accuracy of the Concealed Information Test

The accuracy of the Concealed Information Test has been examined in the laboratory by using the mock crime procedure. This procedure consists of allocating participants randomly to either the "innocent" or the "guilty" condition. Participants enacting the guilty condition are requested to commit a mock crime (e.g., stealing some money), while participants simulating the innocent condition are not involved in the mock crime. Participants from both conditions are instructed to try to appear innocent during a subsequent polygraph interrogation. Based upon this polygraph examination, the examiner makes a judgment on whether or not the participants had crime knowledge. The correctness of this judgment determines the accuracy of the test. The sensitivity concerns the accuracy in judging the deceptive participants, and the specificity regards the accuracy in classifying the innocent participants. Mock crime studies have been reviewed by several authors (Ben-Shakhar & Elaad, 2003; Ben-Shakhar & Furedy, 1990; MacLaren, 2001; National Research Council, 2003). These reviews have shown that the Concealed Information Test performs well above chance, but errors frequently occur, mainly in detecting deception. For example, in his review of 22 mock crime studies, MacLaren (2001) found that the Concealed Information Test provided an accurate judgment for 76% of the guilty, and 83% of the innocent participants. Ben-Shakhar and Elaad (2003) selected 10 high quality mock crime studies and also found that the sensitivity of the Concealed Information Test was lower than its specificity (83% vs. 96%; Ben-Shakhar, personal communication, 2004). This difference is even more pronounced in field research, where test outcome was found correct in only 65-76% of the guilty suspects, compared to 94% of the innocent suspects (Elaad, 1990; Elaad, Ginton, & Jungman, 1992). These studies confirm the validity of the Concealed Information Test, but indicate that deception remains undetected in a significant number of guilty suspects.

Theory of the Concealed Information Test

Physiological reactivity in polygraph tests is often believed to result from strong emotions such as fear or guilt. The Concealed Information Test, how-

ever, can be highly effective even when no strong emotions are involved. It is highly unlikely that a participant in a card test is sweating from a guilty conscience. This argument is further illustrated by clinical applications of the Concealed Information Test. Bauer (1984) used the Concealed Information Test to evaluate the memory of a prosopagnostic patient. This patient was unable to report verbally the names of familiar faces, such as the faces of friends, family members or even his own image in the mirror. The patient was shown the faces of familiar persons with either the correct or an incorrect name written beneath the pictures. The patient could not link the names with the corresponding faces, but he often displayed the largest physiological response to the correct names. Again, it is highly unlikely that the physiological reactions resulted from guilt or fear to fail the polygraph test. This is why the Concealed Information Test is more likely to be based on cognitive rather than on emotional factors (Ben-Shakhar & Furedy, 1990). A highly influential cognitive account was formulated by Lykken (1974), who argued that the orienting reflex drives physiological reactivity in the Concealed Information Test. The orienting reflex is a physiological response elicited by novel and/or significant stimuli (Sokolov, 1963). Novel stimuli elicit orienting because they do not fit in the organism's mental model of the surrounding world. The organism orients towards novel stimuli in order to analyse them more thoroughly. After a period, these stimuli will be taken into the new mental model and orienting will be inhibited (habituation). For example, a car that passes your window will probably draw your attention. However, if you live next to a motorway, this sound will be adopted in your mental model and orienting will no longer take place. Familiar stimuli can also elicit orienting, provided they are in some way relevant to the individual. Your own name, for example, is likely to draw your attention, even when you are paying attention to other stimuli. As the correct answers in a Concealed Information Test have special significance only for knowledgeable individuals, only they will display enhanced orienting to the correct answers. Thus, the chosen card, the patient's own name and secret crime information elicit enhanced physiological responding because they are more relevant than the non-chosen cards, incorrect names, and control information respectively. Research has generally supported the orienting theory of the Concealed Information Test. It has, for example, been shown that concealed information is associated with the same physiological reactions that are elicited by the orienting reflex, such as an increase in skin conductance, respiratory suppression, and cardiac deceleration (for a review of the evidence see Verschuere, Crombez, De Clercq, & Koster, 2004).

Motivation and emotion might not explain the efficacy of the Concealed Information, but they can contribute to responding. Laboratory research has shown that the motivation to appear innocent and overtly deny knowledge

can enhance the physiological responding to concealed information (Ben-Shakhar & Elaad, 2003). It is possible that these factors uniquely and independently produce enhanced physiological reactions. For instance, the “motivation impairment effect” states that the harder people try to deceive, the easier they are caught (Burgoon, 2000). Inhibitory processes might explain why deception itself results in physiological activation (Langleben et al., 2002). These findings can, however, also be integrated within the orienting theory. Any manipulation that increases the relevance of a stimulus will increase the magnitude of the orienting reflex elicited by it (Ben-Shakhar & Elaad, 2003). Clearly, the relevance of concealed information is increased by raising the stakes and by instructing the participant overtly to answer deceptively. Until falsified by empirical evidence, the most economic theoretical account is that motivation and deception influence physiological responding through the orienting mechanism.

In sum, the Concealed Information Test uses psychophysiological measures to evaluate the presence of concealed information. This psychophysiological assessment can be of use when a participant is unable or unwilling to report certain knowledge. Laboratory research has confirmed that the accuracy of this assessment is good, but that as many as 16-35% of deceptive examinees remain undetected. The mechanism driving the physiological responses to concealed information is unlikely to be guilt or fear. Instead, reactivity to concealed information results from orienting to relevant information. Next, we will discuss the psycho(physio-)logical reasons why orienting to concealed information may be moderated by psychopathy.

The Psychophysiology of Psychopathy

Research on psychopathy has long been characterised by a confounding of the concepts criminality, antisociality and psychopathy. In 1941, Cleckley published a book entitled *The Mask of Sanity*, in which he lively describes some of his psychopathic patients. His clinical description of psychopathy contained both emotional (lack of remorse, shallow affect, etc.), and behavioural symptoms (unreliability, impulsivity, antisocial behaviour, etc). According to Cleckley, criminal behaviour was neither a necessary nor a sufficient factor for the diagnosis of psychopathy. Cleckley’s clinical description of psychopathy provided the basis for the Psychopathy Checklist and the Psychopathy Checklist – Revised (PCL-R; Hare, 2003), which is now the standard for the assessment of psychopathy. The 20 items of this checklist aimed at capturing Cleckley’s clinical description. Based upon a structured interview and collateral file information, the items are scored on their presence (0 = not present, 1 = perhaps/partly present, 2 = certainly present). Thus,

scores on the PCL-R can vary from 0 to 40, with 26 (West-Europe) or 30 (United States) serving as a cut-off for a psychopathy diagnosis. Factor analytic work has shown that the PCL-R encompasses two factors. The first factor (F1) involves affective-interpersonal symptoms, and the second (F2) holds behavioural-lifestyle symptoms. These two factors show a different pattern of relation with external criteria, such as personality measures, demographic variables and laboratory tasks of affective and cognitive functioning (see e.g., Hare, 2003). Factor 1 ("emotional detachment"; Patrick, Bradley, & Lang, 1993) is negatively related to anxiety, and positively to narcissism and dominance. Factor 2 ("antisocial behaviour"; Patrick et al., 1993) correlates negatively with socioeconomic status and intelligence, positively with impulsivity and substance abuse, and is closely linked to the Antisocial Personality Disorder described in the DSM-IV (Hare, Hart, & Harpur, 1991; Harpur et al., 1989). Correlations between the two factors are modest, leading to the possibility that an individual can be emotionally detached without engaging in criminal behaviour (and vice versa). Of importance for the Concealed Information Test is the finding that these two dimensions also have different psychophysiological correlates.

Factor 1. Emotional detachment, and impaired fear responding

One of the earliest experimental investigations of the emotional deficit in psychopathy was the study by Lykken (1957). Prisoners were allocated to a psychopathic or a non-psychopathic group based on clinical judgment. All prisoners participated in an aversive conditioning experiment in which a bell preceded the occurrence of an electroshock. The results showed that the psychopathic prisoners showed less anticipatory skin conductance activity compared to the non-psychopathic prisoners. Lykken interpreted these results as evidence for his low-fear hypothesis, which narrows shallow affect to a fear deficit. Later on, methodologically more sophisticated studies have generally confirmed Lykken's original findings.

Important evidence on impaired emotional responding in psychopathy comes from a series of studies by Patrick and colleagues using the startle eye blink paradigm (e.g., Patrick et al., 1993). The eye blink reflex is a component of the startle reflex that is elicited by intense stimuli, for example a loud burst of white noise. The size of this reflex is reliably moderated by the ongoing affective state of the participant. Relative to a neutral state, a positive state inhibits, and a negative state facilitates startle responding. This affective startle modulation effect was first shown by Vrana et al. (1988). In this study, college students were presented with neutral (e.g., household objects), positive (e.g., smiling baby) and negative (e.g., mutilated bodies) pictures, selected from the International Affective Picture System (IAPS; Lang et al., 1999).

While looking at these pictures, an aversive burst of noise was occasionally presented. As predicted, a linear relationship between picture valence and the size of the startle eye blink was found, with smallest blinks during the positive pictures and largest blinks during negative pictures. Subsequent research has replicated this finding using different affective stimuli, different startling stimuli, and different subjects (for a review see Lang, Bradley, & Cuthbert, 1997). The startle potentiation by aversive stimuli has been interpreted as a fear response. This reasoning is supported by the finding that aversive startle potentiation is abolished by anxiolytic medication (Patrick et al., 1996). Patrick et al. (1993) used the startle paradigm to re-investigate Lykken's low-fear hypothesis. These authors applied the affective startle modification paradigm in 54 sexual offenders. Based upon PCL-R scores, these prisoners were allocated to a non-psychopathic ($PCL-R < 21$), mixed ($20 < PCL-R < 30$), and psychopathic group ($PCL-R > 30$). The typical linear trend in startle modulation (positive < neutral < negative) was found in both the non-psychopathic and the mixed psychopathic group. The psychopaths, however, displayed the normal startle inhibition on the positive pictures, but failed to show startle facilitation on the negative pictures. Further analyses demonstrated that this fear deficit was specifically related to the emotional component of psychopathy. When high antisocial prisoners were subdivided as scoring high or low on shallow affect, the startle deficit appeared specific to the emotionally blunted prisoners. This finding has been replicated by Herpertz et al. (2001), Levenston, Patrick, Bradley, and Lang (2000), Pastor, Molto, Vila, and Lang (2003), and Vanman, Mejia, Dawson, Schell, and Raine (2003).

The evidence on impaired responding to aversive stimulation has led several authors to theorise that psychopathy originates from a deficit in the neurophysiological fear system. This brain system has been called the behavioural inhibition system (BIS; Gray, 1987). The BIS is sensitive to cues for punishment, non-reward, as well as novelty. It inhibits behaviour that might lead to aversive outcomes and is accompanied by the feeling of anxiety. According to Gray, differences in BIS sensitivity explain individual differences in anxiety proneness. At one extreme, individuals in risk of anxiety disorders may be found, whereas psychopathic individuals may be found at the other extreme of the continuum. Thus, a weak BIS might explain why psychopathic individuals show reduced autonomic responding to aversive stimulation. It is reasoned that this fearlessness is a predisposition to psychopathy (Lykken, 1995). In normal development, socialisation prevents youth from acting criminal behaviour. When the growing child has no fear of punishment, aversive conditioning will be unsuccessful, and the child is likely to engage in antisocial behaviour.

Factor 2. Antisocial behaviour, and reduced orienting

Other researchers have focused upon the psychophysiological correlates of antisocial behaviour. A meta-analysis, encompassing 95 studies, showed that antisocial disorders are associated with reduced skin conductance activity at rest, during tasks and in response to a variety of external stimuli (Lorber, 2004). Our focus will be on this latter, stimulus-related reduced activation, because it is believed to be of the most relevance for orienting to concealed information.

In adults, reduced skin conductance orienting has been observed in psychopathic individuals. Pastor et al. (2003), for example, examined physiological activation to emotional and neutral pictures in prisoners who were allocated to a non-psychopathic, mixed psychopathic and psychopathic group based upon PCL-R criteria. Both the psychopathic and the mixed psychopathic prisoners showed reduced skin conductance activity to all pictures. This reduced activation was not specific for the aversive pictures (but found with all pictures), and not specific for the high psychopathic group (but also found in prisoners with moderately elevated psychopathy scores). These data, therefore, are suggestive of a broad orienting deficit in antisocial offenders (for a review see Raine, 1997).

Autonomic underactivation has also been observed in antisocial children and adolescents. Herpertz et al. (2003), for example, compared physiological responding to innocuous tones in 8-13 year old normal boys, and boys diagnosed with either conduct disorder, ADHD, or both. In a classic orienting paradigm, the boys were presented with 10 presentations of a 65 dB tone, while measuring physiological responding. Compared to both controls and boys with ADHD, the boys with conduct disorder alone and with comorbid ADHD displayed smaller skin conductance orienting to the tones. Fung et al. (2005) assessed a large group of male adolescents ($n = 335$) with the Lynam's Child Psychopathy Scale and assigned them to either a psychopathy-prone ($n = 65$) or control group ($n = 65$). All boys participated in a countdown stressor task, in which an aversive noise occurred either unpredictably or preceded by a countdown from 12 to 0. It was found that, compared to the control condition, a higher percentage of the psychopathy-prone boys did not display any skin conductance activity in anticipation of the aversive noise. In further analyses, both groups were divided in high versus low delinquent groups. It appeared that the high delinquent controls displayed the same underactivation as the high delinquent psychopathy-prone boys. Thus, the results showed that the underactivation was not specific to psychopathy proneness, but rather to delinquency in general.

Eysenck (1964) reasoned that the physiological underarousal is an aversive state, and stimulates the individual to stimulation-seeking behaviour in

order to optimise the arousal level. Regarding antisocial activity as a deviant form of stimulation seeking, it becomes clear why underarousal may be a risk factor for criminal behaviour (see e.g., Raine, 1997). Interestingly, whereas weak autonomic activation may be a risk factor for criminality, heightened autonomic activation may be a protective factor for criminality. Indeed, Brennan et al. (1997) compared orienting responses to neutral tones in criminal and non-criminal males with criminal or non-criminal fathers. The non-criminal subjects with criminal fathers appeared to show elevated orienting responses compared to all other groups. Taking parental criminality as a risk factor for criminality, the authors concluded that this heightened autonomic activity may have prevented these subjects from engaging in criminal acts.

Taken together, psychophysiological research on psychopathy suggests that the two facets of psychopathy are characterised by distinct psychophysiological correlates. The first factor, emotional detachment, is associated with a reduced responding to aversive stimulation, and has been interpreted by some as a deficit in fear responding. The second factor, antisocial behaviour, is related to autonomic underactivation, and is mainly observed in reduced skin conductance activity. These findings clearly have consequences for the physiological assessment of concealed information in psychopathic individuals. From the present review it would follow that antisocial behaviour rather than emotional detachment might threaten the validity of the Concealed Information Test. Recall that the Concealed Information Test is based upon orienting, not fear. A lack of fear may, therefore, leave the test accuracy unaffected. Autonomic underactivation and impaired orienting, on the other hand, may decrease the sensitivity of the test. A guilty antisocial offender, displaying reduced orienting in the Concealed Information Test, might be judged “non-deceptive”.

We should point out that reduced orienting does not necessarily lead to reduced detection rates in the Concealed Information Test. Indeed, to the extent that the differential responding between the concealed and the control information remains clear, the concealed information can still be detected. However, a substantial reduction or absence of orienting will, however, deteriorate the performance of the Concealed Information Test. The review of the literature does not allow to conclude on how “severe” the orienting deficit is. Given that several studies found reduced occurrence of orienting (Raine, 1997), and that the number of non-responders is elevated in antisocial individuals (see e.g., Fung et al., 2005), the least we can conclude is that antisociality might threaten the validity of the Concealed Information Test.

Psychopathy and the physiological detection of concealed information

Research on the moderating role of psychopathy on the physiological detection of concealed information is scarce and shows inconsistent results. To our knowledge there are only five published studies that have examined the effect of psychopathy on physiological activity in the Concealed Information Test (Balloun & Holmes, 1979; Gudjonsson, 1982; Verschuere, Crombez, De Clercq, & Koster, 2005; Waid, Orne, & Wilson, 1979a, b).

In an early study by Balloun and Holmes (1979), undergraduates were allocated to a low or high antisocial group, based upon their score on the Psychopathic Deviate scale. This subscale of the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway & McKinley, 1943) explicitly assesses antisocial behaviour and attitudes, including disregarding social conventions, non-conformity, impulsivity and hostility. Participants could cheat on an intelligence test and were subsequently questioned on whether they had done so. No difference in skin conductance detection rate was found between the groups. In two other studies (Waid, Orne, & Wilson, 1979a, b) undergraduates, half of which had enacted a mock crime, were engaged in a Concealed Information Test. In both studies, the socialisation scale of the California Psychological Inventory (Gough, 1956) was administered. Like the Psychopathic Deviate Scale of the MMPI, this questionnaire explicitly measures antisocial behaviour, and correlates with self-reported delinquency (Kosson, Steuerwald, Newman, & Widom, 1994). Both experiments demonstrated that less socialised participants showed smaller skin conductance reactions to the concealed information items. This resulted in a relatively higher number of guilty low socialised participants escaping detection. Finally, Gudjonsson (1982) used a card version of the Concealed Information Test in both community volunteers and psychiatric patients. He found no correlation between the socialisation scale and concealed information detection efficiency based on skin conductance responses. Note that these studies only measured the behavioural component of psychopathy, but did not address the affective-interpersonal component. Furthermore, these studies reported detection efficiency in only one response measure, skin conductance reactivity. Moreover, with exception of the psychiatric patients in Gudjonsson (1982), participants in these studies were likely to score on the lower end of the psychopathy continuum.

We tried to address these methodological shortcomings by investigating the effect of both psychopathy components - emotional detachment and antisocial behaviour - on physiological responding to concealed information in a prison sample (Verschuere et al., 2005). Psychopathy was assessed using the Psychopathic Personality Inventory (Lilienfeld & Andrews, 1996). This 187-item questionnaire consists of 8 subscales that capture the well-known two-

dimensional factor structure of psychopathy: “fearless-dominance” (PPI-I), and “antisocial-impulsivity” (PPI-II) (Benning, Patrick, Blonigen, Hicks, & Iacono, 2005; Benning, Patrick, Hicks, Blonigen, & Krueger, 2003). Thirty-seven long-sentenced male prisoners filled in this questionnaire and participated in an autobiographical variant of the Concealed Information Test. The prisoners were presented with personal (e.g., their own first name) and control names and asked to conceal recognition of personal information. As previously observed in undergraduates, the prisoners displayed enhanced orienting to concealed information. Furthermore, antisocial-impulsivity correlated negatively with both orienting to all stimuli and to the differential responding to concealed information. Correlations with cardiac and respiratory orienting were in the same direction, but did not reach significance. No association with fearless-dominance was found.

Five studies have examined the effect of psychopathic traits on physiological responding to concealed information. Three studies found that antisocial behaviour is related to reduced skin conductance orienting to concealed information. As studies differ in a wide range of aspects, among which the population (e.g., students vs. prisoners), the measurement of psychopathy (e.g., MMPI-Pd, So, PPI), and the operationalisation of concealed information (e.g., chosen card, mock crime stimuli, personal information), it is virtually impossible to conclude why some studies failed to find this effect. Taken together, this review suggests that antisocial behaviour *can* lead to reduced skin conductance orienting to concealed information.

The evidence gathered so far shows that only skin conductance responding is impaired in the antisocial personality. One should be cautious in concluding that other response measures do not show the same underactivation. Reduced skin conductance orienting shows high correlates with reduced responding in other autonomic indices of orienting such as heart rate deceleration and peripheral vasoconstriction (Schnur et al., 1995). Several authors have speculated that evoked brain potentials may not be subject to the limitations of autonomic measures (Bashore & Rapp, 1993). Farwell and Donchin (1991) demonstrated that concealed information is followed by a positive peak in the event-related brain potential, the P300. The accuracy of the P300-based detection of concealed information is comparable to that obtained with autonomic measures. Research showing reduced P300 in psychopathy (Kiehl, Hare, Liddle, & McDonald, 1999) suggests that the validity of the P300-based Concealed Information Test may also be moderated by psychopathy. Miller and Rosenfeld (2004) investigated whether psychopathic traits moderate P300 based detection. These authors selected a number of items from the Psychopathic Personality Inventory, mainly stemming from the Machiavellian Egocentricity Scale. In contrast to what the name suggest, this scale measures hostility and disinhibition, and loads on antisocial-impul-

sivity rather than fearless-dominance (Benning et al., 2003). This ad hoc composed scale was administered in a large group of undergraduate students. Thirteen students scoring in the upper range and 11 students scoring in the lower range of the scale participated in an autobiographical Concealed Information Test. No significant group differences were found, but detection in the high scorers (92%) was lower than that in the low scoring group (100%). Interpretation of the results is complicated by several methodological artefacts, among which a confound effect of gender (i.e., male:female ratio was 3:7 in the high and 10:3 in the low scorers). Further studies should re-address this topic, but these preliminary results suggest that antisociality-related reduced detection is likely to generalise across response measures.

Underarousal in antisocial individuals might have profound implications for applied testing. In Japan for instance, the Concealed Information Test is applied on a large scale, with about 5000 tests performed each year (Hira & Furumitsu, 2002). Research in Japan and Israel (Elaad, Ginton, & Jungman, 1992; Nakayama, 2002) has shown that the sensitivity (catching the guilty suspects) of the Concealed Information Test is impaired in real life settings. Several reasons might account for this finding, but the present review indicates that one of these might be that concealed information was undetected in some antisocial culprits. Clearly, this topic needs further investigation. In the final paragraph, we will discuss avenues for research and possible solutions for applied testing.

Directions for future research

The robustness of the link between antisocial behaviour and impaired detection efficiency definitely needs to be established. The available studies have provided mixed evidence and are subject to methodological shortcomings. For example, all studies at present have used self-report measures of psychopathy, which may be biased by response tendencies. Future research should pay close attention to the assessment of psychopathy. The validity of the psychopathy assessment could be strengthened by using additional, objective information. Hare's (2003) Psychopathy Checklist-Revised, for example, takes collateral file information into account. Previous studies also failed to address confounding and moderating variables. Future research should, therefore, adopt demographic variables (e.g., age, gender, and socioeconomic status) and relevant personality constructs (e.g., aggression, anxiety, and schizotypal traits) in their assessment (Lorber, 2004; Raine, 1997). This will allow researchers to investigate whether the reduced detection efficiency in antisociality is real and/or restricted to certain subgroups. Finally, the present review has stressed the importance of assessing different

facets of psychopathy - affective/interpersonal and behavioural/lifestyle symptoms.

Applied Implications

Although far from conclusive, the available evidence suggests that antisociality may be associated with reduced skin conductance responding in the Concealed Information Test. It is, therefore, advisable to assess responding in several response measures prior to the examination with the CIT. This pre-polygraph assessment could assess physiological reactivity at baseline and during a task, but most relevant will be stimulus-related responsivity. The strength of the orienting reflex can be estimated by measuring physiological responding to neutral versus relevant stimuli. An often used methodology is the picture viewing paradigm (Lang et al., 1997), in which neutral and emotional pictures are used. In order to optimise comparability with orienting to concealed information self-relevant stimuli, such as personal names, could be used (Shek & Spinks, 1986). Based on this physiological assessment, the polygrapher could decide to give more weight to a deceptive than to a truthful test outcome, or decide to take a more conservative approach and stop the polygraph test.

Alternatively, one could try to detect concealed information in antisocial individuals by using other response measures. The analysis above, however, questions the efficacy of using additional physiological measures. Another option would be to include non-physiological response measures, such as behavioural cues for deception. Unfortunately, the accuracy of deception detection using demeanour hardly exceeds chance. A recent meta-analysis on 158 possible non-verbal indicators of deception showed that most of them show no or very weak links to deception (DePaulo, Lindsay, Malone, Muhlenbruck, Charlton, & Cooper, 2003). Other measures, such as reaction times (Seymour, Seifert, Shafto, & Mosmann, 2000), show more promise. The validity of these measures and, more relevant for the present argumentation, the influence of psychopathic traits need further investigation.

The present review indicates that autonomic hypo-responsivity is responsible for the reduced detection in antisocial personalities. This conclusion, however, needs two important qualifications. First, alternative explanations for the reduced detection efficiency may be formulated. Antisocial individuals might, for example, be more capable of fooling the polygraph test. That is, they make more effective use of countermeasures. Countermeasures are everything the examinee does in trying to alter the polygraph test outcome. The examinee might, for example, bite his/her tongue in order to create a physical response to the incorrect control items. However, such countermea-

asures can not explain *reduced* reactivity. Alternatively, the examinee could try to reduce his reaction to the correct items, for example, by using mental dissociation. Such countermeasures, however, have been shown ineffective, and even enhance reactivity to the correct items (Elaad & Ben-Shakhar, 1991). Furthermore, there exist global countermeasures aimed at altering physiological reactivity in general (e.g., by taking drugs or using mental dissociation throughout the test). Such countermeasures could in theory explain reduced reactivity in the Concealed Information Test. Several studies, however, have raised doubt on the efficacy of these global countermeasures (Honts & Amato, 2002). Nonetheless, antisocial individuals may be better informed or make more effective use of these countermeasures. Therefore, it seems worthwhile to investigate whether the reduced reactivity in antisocial individuals is due to the use of countermeasures.

Second, psychopaths are hyporesponsive to most stimuli, but may be hyperresponsive to reward. Gorenstein and Newman (1980) have argued that psychopathy results from a heightened activation of the behavioural activation system (BAS). The BAS is the brain system that is responsible for approach behaviour and is sensitive to cues for reward and non-punishment. Activation of the BAS is related to feelings of positive affect. In terms of individual differences in personality, extreme underactivation of the BAS may result in depressive disorders, whereas extreme activation of the BAS may underlie the psychopathic personality. The strong BAS hypothesis has been integrated with the weak BIS hypothesis (Arnett, 1997). Psychopathy would result from an imbalance in BIS and BAS functioning, with an underactive BIS and an overactive BAS. Note, however, that there is good evidence for the weak BIS hypothesis, but that there is yet no direct empirical support for an overactive BAS in psychopathic individuals (for reviews see Arnett, 1997, Beauchaine, 2001, and Lorber, 2004). Applied to the Concealed Information Test, the strong BAS in psychopathy would predict that psychopaths show enhanced physiological reactivity when reward is in sight. Instead of threatening the suspect with prison sentence when failing the polygraph, one should emphasise reward when able to appear innocent. One could, for example, stress the fact that polygraph tests are difficult to beat, but that intelligent people are able to do so).

This review looked at the effect of psychopathy on the detection efficiency of the Concealed Information Polygraph Test. Dismantling the psychopathy concept, the present analysis showed that emotional detachment is associated with deficient fear-potentiated startle, and antisocial behaviour with reduced (skin conductance) orienting. Given its foundation in orienting theory, it follows that the validity of the Concealed Information Test is mainly threatened by antisocial behaviour rather than emotional detachment. The limited research on this topic tends to support this prediction. If future

research confirms the reliability of this finding, current polygraph practice needs to be revised. We recommend a pre-polygraphic assessment of psychopathy and physiological responding (i.e., orienting). Furthermore, increasing arousal, for example by emphasising reward, might increase the detection efficiency in antisocial individuals.

References

- Arnett, P.A. (1997). Autonomic responsivity in psychopaths: a critical review and theoretical proposal. *Clinical Psychology Review*, 17, 903-936.
- Balloun, K.D., & Holmes, D.S. (1979). Effects of repeated examinations on the ability to detect guilt with a polygraph examination: A laboratory experiment with a real crime. *Journal of Applied Psychology*, 64, 316-322.
- Bashore, T.R., & Rapp, P.E. (1993). Are there alternatives to traditional polygraphs? *Psychological Bulletin*, 113, 3-22.
- Bauer, R.M. (1984). Autonomic recognition of names and faces in prosopagnosia – A neuropsychological application of the guilty knowledge test. *Neuropsychologia*, 22, 457-469.
- Beauchaine, T. (2001). Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Development and Psychopathology*, 13, 183-214.
- Benning, S.D., Patrick, C.J., Blonigen, D.M., Hicks, B.M., & Iacono, W.G. (2005). Estimating facets of psychopathy from normal personality traits: A step towards community-epidemiological investigations. *Assessment*, 12, 3-18.
- Benning, S.D., Patrick, C.J., Hicks, B.M., Blonigen, D.M., & Krueger, R.F. (2003). Factor structure of the Psychopathy Personality Inventory: Validity and implications for clinical assessment. *Psychological Assessment*, 15, 340-350.
- Ben-Shakhar, G., Bar-Hillel, M., & Kremnitzer, M. (2002). Trial by polygraph: reconsidering the use of the guilty knowledge technique in court. *Law and Human Behavior*, 26, 527-541.
- Ben-Shakhar, G., & Elaad, E. (2003). The validity of psychophysiological detection of information with the Guilty Knowledge Test: A meta-analytic interview. *Journal of Applied Psychology*, 88, 131-151.
- Ben-Shakhar, G., & Furedy, J. (1990). *Theories and applications in the detection of deception*. New York: Springer-Verlag.
- Brennan, P.A., Raine, A., Schlusinger, F., KirkegaardSorenson, L., Knop, J., Hutchings, B., Rosenberg, R., & Mednick, S.A. (1997). Psychophysiological protective factors for male subjects at high risk for criminal behavior. *American Journal of Psychiatry*, 154, 853-855.
- Burgoon, J.K. (2000). Testing for the motivation impairment effect during deceptive and truthful interaction. *Western Journal of Communication*, 64, 243-267.
- Cleckley, H. (1941). *The mask of sanity*. St. Louis, MO: Mosby.
- DePaulo, B.M., Lindsay, J.J., Malone, B.E., Muhlenbruck, L., Charlton, K., & Cooper, H. (2003). Cues to deception. *Psychological Bulletin*, 129, 74-118.
- Elaad, E. (1990). Detection of guilty knowledge in real-life criminal investigations.

- Journal of Applied Psychology*, 75, 521-529.
- Elaad, E., & Ben-Shakhar, G. (1991). Effects of mental countermeasures on psychophysiological detection in the guilty knowledge test. *International Journal of Psychophysiology*, 11, 99-108.
- Elaad, E., Ginton, A., & Jungman, N. (1992). Detection measures in real-life criminal guilty knowledge tests. *Journal of Applied Psychology*, 77, 757-767.
- Eysenck, H.J. (1964). *Crime and personality*. London: Methuen.
- Farwell, L.A., & Donchin, E. (1991). The truth will out: Interrogative polygraphy ("lie detection") with event-related potentials. *Psychophysiology*, 28, 531-547.
- Fung, M.T., Raine, A., Loeber, R., Lynam, D.R., Steinhauer, S.R., Venables, P.H., & Stouthamer-Loeber, M. (2005). Reduced electrodermal activity in psychopathy-prone adolescents. *Journal of Abnormal Psychology*, 114, 187-196.
- Gorenstein, E.E., & Newman, J.P. (1980). Disinhibitory psychopathology: A new perspective and a model for research. *Psychological Review*, 87, 199-204.
- Gough, H.G. (1956). *California psychological inventory*. Palo Alto, UK: Consulting Psychologists Press.
- Gray, J.A. (1987). *The psychology of fear and stress*. Cambridge: Cambridge University Press.
- Gudjonsson, G.H. (1982). Some psychological determinants of electrodermal responses to deception. *Personality and Individual Differences*, 3, 381-391.
- Hare, R.D. (2003). *The Hare Psychopathy Checklist-Revised: Second Edition*. Toronto: Multi-Health Systems.
- Hare, R.D., Hart, S.D., & Harpur, T.J. (1991). Psychopathy and the DSM-IV criteria for antisocial personality disorder. *Journal of Abnormal Psychology*, 100, 391-398.
- Harpur, T.J., & Hare, R.D. (1994). Assessment of psychopathy as a function of age. *Journal of Abnormal Psychology*, 103, 604-609.
- Harpur, T.J., Hare, R.D., & Hakstian, A.R. (1989). Two-factor conceptualization of psychopathy: Construct validity and assessment. *Psychological Assessment*, 1, 6-17.
- Hathaway, S.R., & McKinley, J.C. (1943). *The Minnesota Multiphasic Personality Inventory*. Minneapolis: University of Minnesota Press.
- Herpertz, S.C., Mueller, I.R., Wenning, B., Qunabi, M., Lichterfeld, C., & Herpertz-Dahlman, B. (2003). Autonomic responses in boys with externalizing disorders. *Journal of Neural Transmission*, 110, 1181-1195.
- Herpertz, S.C., Werth, U., Lucas, G., Qunabi, M., Schuerkens, A., Kunert, H.J., Freese, R., Flesch, M., Mueller, I.R., Osterheider, M., & Sas, H. (2001). Emotion in criminal offenders with psychopathy and borderline personality disorder. *Archives of General Psychiatry*, 58, 737-745.
- Hira, S., & Furumitsu, I. (2002). Polygraphic examinations in Japan: Applications of the guilty knowledge test in forensic investigations. *International Journal of Police Science and Management*, 4, 16-27.
- Honts, C.R. (1994). Physiological detection of deception. *Current Directions in Psychological Science*, 3, 77-82.
- Honts, C.R. (2003). The psychophysiological detection of deception. In P.A. Granhag & L.A. Strömwall (Eds), *The Detection of Deception in Forensic Contexts* (pp. 103-123). Cambridge: Cambridge University Press.

- Honts, C., & Amato, S. (2002). Countermeasures. In M. Kleiner (Ed.), *Handbook of polygraph testing* (pp.251-264). London: Academic Press.
- Iacono, W.G., & Lykken, D.T. (1997). The validity of the lie detector: Two surveys of scientific opinion. *Journal of Applied Psychology*, 82, 426-433.
- Kiehl, K.A., Hare, R.D., Liddle, P.F., & McDonald, J.J. (1999). Reduced P300 responses in criminal psychopaths during a visual oddball task. *Biological Psychiatry*, 45, 1498-1507.
- Kosson, D.S., Steuerwald, B.L., Newman, J.P., & Widom, C.S. (1994). The relation between socialisation and antisocial behaviour, substance abuse, and family conflict in college students. *Journal of Personality Assessment*, 63, 473-488.
- Lang, P.J., Bradley, M.M., & Cuthbert B.N. (1997). Emotion, attention, and the startle reflex. *Psychological Review*, 97, 377-395.
- Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1999). *The International Affective Picture System (IAPS): Technical manual and affective ratings*. Gainesville, FL: Center for the study of emotion and attention, University of Florida.
- Langleben, D.D., Schroeder, L., Maldjian, J.A., Gur, R.C., McDonald, S., Ragland, J.D., O'Brian, C.P., & Childress, A.R. (2002). Brain activity during simulated deception: An event-related functional magnetic resonance study. *Neuroimage*, 15, 727-732.
- Levenston, G.K., Patrick, C.J., Bradley, M.M., & Lang, P.J. (2000). The psychopath as observer: Emotion and attention in picture processing. *Journal of Abnormal Psychology*, 109, 373-385.
- Lilienfeld, S.O., & Andrews, B.P. (1996). Development and preliminary evidence of a self-report measurement of psychopathic traits in noncriminal populations. *Journal of Personality Assessment*, 66, 488-524.
- Lorber, M.F. (2004). Psychophysiology of aggression, psychopathy, and conduct problems: A meta-analysis. *Psychological Bulletin*, 130, 531-552.
- Lykken, D.T. (1957). A study of anxiety in the sociopathic personality. *Journal of Abnormal and Clinical Psychology*, 55, 6-10.
- Lykken, D.T. (1974). Psychology and the lie detector industry. *American Psychologist*, 29, 725-739.
- Lykken, D.T. (1995). *The Antisocial Personalities*. Hillsdale, NJ: Erlbaum.
- MacLaren, V. (2001). A quantitative review of the Guilty Knowledge test. *Journal of Applied Psychology*, 86, 674-683.
- Miller, A.R., & Rosenfeld, J.P. (2004). Response-specific scalp distributions in deception detection and ERP correlates of psychopathic personality traits. *Journal of Psychophysiology*, 18, 13-26.
- Nakayama, M. (2002). Practical use of the concealed information test for criminal investigations in Japan. In M. Kleiner (Ed.), *Handbook of polygraph testing* (pp. 1-47). London: Academic Press.
- National Research Council (2003). *The polygraph and lie detection. Committee to review the scientific evidence on the Polygraph*. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.
- Patrick, C.J., Berthot, B.D., & Moore, J.D. (1996). Diazepam blocks fear-potentiated startle in humans. *Journal of Abnormal Psychology*, 105, 89-96.
- Patrick, C.J., Bradley, M.M., & Lang, P.J. (1993). Emotion in the criminal psychopath – Startle reflex modulation. *Journal of Abnormal Psychology*, 102, 82-92.

- Pastor, M.C., Molto, J., Vila, J., & Lang, P.J. (2003). Startle reflex modulation, affective ratings and autonomic reactivity in incarcerated Spanish psychopaths. *Psychophysiology*, 40, 34-938.
- Raine, A. (1997). Psychophysiology of antisocial behavior. In D. Stoff, J. Breiling, & J.D. Maser (Eds.), *Handbook of antisocial behavior* (pp. 289-304). New York: Wiley.
- Reid, J.E. (1947). A revised questioning technique in lie-detection tests. *Journal of Criminal Law and Criminology*, 37, 542-547.
- Schnur, D.B., Bernstein, A.S., Yeager, A., Smith, S., & Bernstein, P. (1995). The relationship of the skin-conductance and finger pulse amplitude components of the orienting response to season of birth in schizophrenia and depression. *Biological Psychiatry*, 37, 34-41.
- Seymour, T.L., Seifert, C.M., Shafit, M.G., & Mosmann, A.L. (2000). Using response time measures to assess "guilty knowledge". *Journal of Applied Psychology*, 85, 30-37.
- Shek, D.T.L., & Spinks, J.A. (1986). A study of the attentional changes accompanying orienting to different types of change stimuli. *Acta Psychologica*, 61, 153-166.
- Sokolov, E.N. (1963). *Perception and the conditioned reflex*. New York: Macmillan.
- Vanman, E.J., Mejia, V.Y., Dawson, M.E., Schell, A.M., & Raine, A. (2003). Modification of the startle reflex in a community sample: Do one or two dimensions of psychopathy underlie emotional processing? *Personality and Individual Differences*, 35, 2007-2021.
- Verschuere, B., Crombez, G., De Clercq, A., & Koster, E.H.W. (2004). Autonomic and behavioral responding to concealed information: Differentiating orienting and defensive responses. *Psychophysiology*, 41, 461-466.
- Verschuere, B., Crombez, G., De Clercq, A., & Koster, E. (2005). Psychopathic traits and autonomic responding to concealed information in a prison sample. *Psychophysiology*, 42, 239-245.
- Vrana, S.R., Spence, E.L., & Lang, P.J. (1988). The startle probe response: A new measure of emotion? *Journal of Abnormal Psychology*, 97, 487-491.
- Waid, W.M., Orne, M.T., & Wilson, S.K. (1979a). Effects of socialisation on electrodermal detection of deception. *Psychophysiology*, 16, 15-22.
- Waid, W.M., Orne, M.T., & Wilson, S.K. (1979b). Socialisation, awareness, and the electrodermal response to detection of deception and self disclosure. *Journal of Abnormal Psychology*, 88, 663-666.

Received June, 2005

Revision Received October, 2005

Accepted October, 2005