Psychophysiology, 42 (2005), 239–245. Blackwell Publishing Inc. Printed in the USA.

DOI: 10.1111/j.1469-8986.2005.00279.x

Psychopathic traits and autonomic responding to concealed information in a prison sample

BRUNO VERSCHUERE,[a] GEERT CROMBEZ,[a] ARMAND DE CLERCQ,[b] AND ERNST H. W. KOSTER[a]

[a]Department of Psychology, Ghent University, Ghent, Belgium
[b]Department of Applied Mathematics and Computer Science, Ghent University, Ghent, Belgium

Abstract

We examined the role of psychopathic traits on physiological responding during a concealed information polygraph test among prison inmates ($n = 40$). The Psychopathic Personality Inventory (Lilienfeld & Andrews, 1996) was used to assess psychopathic traits. Cardiac, electrodermal, and respiratory responses were measured while participants were presented with personal and control names and asked to conceal recognition of personal information. We first piloted the present concealed information test in a sample of undergraduates ($n = 27$). Enhanced orienting to concealed information compared to control information was observed in both prisoners and undergraduates. However, prisoners scoring high on the Impulsive Antisociality factor of the Psychopathic Personality Inventory (PPI-II) exhibited reduced electrodermal responding. This finding indicates that the sensitivity of the concealed information test may be decreased in antisocial offenders.

Descriptors: Antisocial behavior, Psychopathy, Concealed information test, Arousal, Guilty knowledge test, Deception

How do psychopathic individuals respond to the polygraph (“lie detector”)? Clearly, the answer to this question has important implications for authorities relying on polygraph tests in criminal investigations. Although most clinicians and layman undoubtedly think that psychopathic individuals are able to beat the polygraph, research is inconclusive. In general, polygraph-supported interrogations are conducted with (variants of) the control question technique. In this test, a comparison is made between physiological responses on relevant questions (e.g., “Did you steal a Ferrari on the 6th of July?”) and arousal-evoking control questions (e.g., “Prior to the 6th of July, did you ever take anything that did not belong to you?”). It is assumed that the guilty suspect will react more strongly to the relevant questions, whereas the innocent is assumed to react more strongly to the control questions. Raskin and Hare (1978) were the first to demonstrate that the control question polygraph test detects deception in psychopaths as accurately as in nonpsychopaths (for a critique, see Lykken, 1978). Subsequent research has replicated this finding (Honts, Raskin, & Kircher, 1985; Patrick & Iacono, 1989). The control question technique has, however, received severe critiques on both logical and ethical grounds (see, e.g., Ben-Shakhar & Furedy, 1990).

The concealed information test or guilty knowledge test (Lykken, 1959) has been proposed as a scientifically valid alternative to the traditional control question test (Ben-Shakhar, Bar-Hillel, & Kremnitzer, 2002). The concealed information test examines deceit more indirectly and looks much like a multiple choice examination. The suspect is questioned on knowledge about a crime that only the guilty suspect can have. Building on the example above, the suspect could be asked: “If you are the thief, you would know what the owner of the car left on the front seat. Was this a coat? . . . a laptop? . . . a sandwich? . . . a pack of cigarettes? . . . a hat?” Several questions of this kind are formulated, and if the suspect systematically reacts more strongly to the correct alternative, it is assumed that the suspect has concealed information about the crime under investigation. The accuracy of the concealed information test has been extensively examined and it has been demonstrated that it performs well above chance (National Research Council, 2003). Based upon his quantitative meta-analysis, MacLaren (2001) estimated that the concealed information test provides an accurate judgment for 83% of the “innocent” and 76% of the “guilty” participants. Furthermore, the concealed information test relies on sound theoretical grounds. Lykken (1974) has argued that the enhanced physiological responding to concealed information is based on the orienting response (Sokolov, 1963). The orienting response is a complex of behavioral and physiological responses elicited by

The authors thank the director, guards, and the psychological service of State Prison Leuven for their enthusiastic aid in conducting this study. In addition, we are grateful to Karen Descheemaeker for collecting the data of the pilot study. Finally, we thank Scott Vrana, Gershon Ben-Shakhar, Scott Lilienfeld, and an anonymous reviewer for their constructive comments on an earlier version of this article.

Address reprint requests to: Bruno Verschuere, Ghent University, Department of Psychology, Henri Dunantlaan 2, B-9000 Ghent, Belgium. E-mail: Bruno.Verschuere@ugent.be.

either new or significant stimuli. For the guilty suspect, the correct answers are significant and will therefore elicit greater orienting reflexes as compared to the incorrect answers. From the perspective of the innocent suspect, all answers in the concealed information test are homogeneous, leading to a $1/n$ chance of reacting more strongly to the correct alternative (with n being the number of answer possibilities). Several predictions resulting from this hypothesis have been tested and have provided strong support in favor of the orienting account (Verschuere, Crombez, Declercq, & Koster, 2004).

An important question is to what extent psychopathic individuals react in a similar way to concealed information. A few studies have examined whether the accuracy of the concealed information test is moderated by antisocial behavior, a concept related to psychopathy. In an experiment by Balloun and Holmes (1979), undergraduate students had the chance of cheating on an intelligence test and were subsequently questioned on their cheating behavior using a concealed information test. Participants were allocated to a low or high antisocial group, based upon their score on the psychopathic deviate scale of the Minnesota Multiphasic Personality Inventory (Hathaway & McKinley, 1943). Using skin conductance responses, no differences in detection rate were found between high and low antisocial individuals. In two other studies (Waid, Orne, & Wilson, 1979a, 1979b) undergraduates, half of which had enacted a mock crime, were engaged in a concealed information test. In both studies, the socialization scale of the California Psychological Inventory (Gough, 1956) was administered. The findings of both experiments contradicted those of Balloun and Holmes (1979) in that less socialized participants showed smaller skin conductance reactions to the relevant items and that a relatively higher number of guilty low socialized participants were incorrectly judged as being truthful. Finally, Gudjonsson (1982) used a card version of the concealed information test in a sample of normal and psychiatric patients. He found no correlation between the socialization scale and concealed information test accuracy based on skin conductance responses.

The relationship between psychopathy and physiological detection of concealed information remains unclear. Results are inconsistent and conclusions from these studies are restricted by methodological shortcomings. First, all studies used nonincarcerated subjects. Because lower levels of psychopathic traits can be expected in the normal population compared to the prison population, this method is suboptimal to find individual differences. Second, the validity of the psychopathy measures in these studies have been critized. Both the psychopathic deviate and the socialization scale assess antisocial behavior, but not the affective-interpersonal features of psychopathy. Indeed, psychopathy is commonly conceptualized as two-dimensional. The first dimension consists of affective-interpersonal features, such as superficial charm, lack of empathy, affective shallowness, egocentricity, lying, and manipulativeness; the second dimension comprises antisocial behavior such as juvenile delinquency, aggressive behavior, and irresponsibility. The best-validated instrument of psychopathy (i.e., the Psychopathy Checklist; Hare, 1991) assesses both dimensions. Using a large sample of prison inmates, Harpur, Hare, and Hakstian (1989) have demonstrated that both the psychopathic deviate scale and the socialization scale are moderately related to the antisocial factor, but are uncorrelated to the affective-interpersonal dimension of the Psychopathy Checklist. This led the authors to conclude that both scales provide an incomplete picture of the psychopathic personality. To encompass both critiques, we measured both dimensions of psychopathy in a sample of prison inmates. Psychopathic personality traits were assessed using the Psychopathic Personality Inventory (Lilienfeld & Andrews, 1996). A total score can be derived from this 187-item questionnaire that can be interpreted as a global measure of psychopathy. The Psychopathic Personality Inventory, however, differs from other self-report measures of psychopathy in that it measures several aspects of the psychopathic personality along eight subscales: impulsive nonconformity, blame externalization, Machiavellian egocentricity, carefree nonplanfulness, stress immunity, social potency, fearlessness, and coldheartedness. Importantly, recent factor analytic work (Benning, Patrick, Hicks, Bloningen, & Krueger, 2003; Benning, Patrick, Bloningen, Hicks, & Iacono, in press) has shown that the Psychopathic Personality Inventory comprises the two-dimensional structure of psychopathy, similar to that of the Psychopathy Checklist. The first factor (PPI-I), labeled "Fearless Dominance," consists of the subscales stress immunity, social potency, and fearlessness. The second factor (PPI-II), labeled "Impulsive Antisociality," consists of the subscales impulsive nonconformity, blame externalization, Machiavellian egocentricity, and carefree nonplanfulness.

In this study, we assessed psychopathic traits in prison inmates and investigated their relationship with physiological responding to concealed information. To the best of our knowledge, our study is the first to examine the moderating role of psychopathic features on responding to concealed information in a prison sample. We used a personal items variant of the concealed information test, in which participants viewed personal (e.g., participant's first name) and control names on the computer screen and were instructed to hide recognition of personal information. For comparison purposes, a pilot study was first performed in undergraduate students. Next, applying the personal items concealed information test to a sample of prison inmates, we examined whether responding to concealed information was moderated by the Fearless Dominance and/or the Impulsive Antisociality factor of the Psychopathic Personality Inventory.

PILOT STUDY

Method

Participants

Twenty-seven undergraduate students (23 female) of Ghent University took part as partial fulfilment of course requirements. Mean age was 18.63 years ($SD = 1.32$).

Procedure

The experiment was conducted in a sound-attenuated, darkened laboratory, which was connected via an intercom and a one-way vision screen to an adjacent control room. Participants were informed about the procedure and goal of the study and signed an informed consent form. Participants filled in a short questionnaire, which asked them to name personally important individuals (e.g., parents, siblings, friends, (ex-)partner(s), etc.). Prior to the attachment of the electrodes, participants were requested to wash their hands.

Participants were informed that they were going to take part in a lie detection experiment and they were asked to try to beat the polygraph by hiding recognition of personal information.

Participants were seated approximately 50 cm from the screen. The concealed information test consisted of two blocks of eight names. Each block started with a buffer name, followed by four personal and four control names in one of four fixed random orders. Stimulus presentation was random in these orders, with the exception that (a) half of them started with a personal name and the other half with a control name, and (b) there were not more than three consecutive presentations of one stimulus type (personal or control). For each block, participants were randomly allocated to one out of the four randomization orders. Personal names (first name, last name, first name of the father, and first name of the mother) were selected from the questionnaire that was assessed earlier in the session. Control names were selected prior to the experiment, but checked (and if necessary changed) to ensure that they did not resemble any of the names from the questionnaire. All names were presented in the middle of the screen during 6 s, with an interstimulus interval (ISI) ranging from 26 to 30 s. Each block also contained two digit trials (i.e., a random number between 1 and 10) that were presented for 2.5 s. The digits were presented at a fixed pseudorandom position during the ISI, so that the digits did not appear within 10 s after stimulus onset or 16 s prior to stimulus onset. To ensure that participants' attention was focused on the screen, they were asked to name these digits out loud.

Recording and Scoring of Psychophysiological Signals

All stimuli were presented by a first PC using Inquist software (Millisecond Software). A Lablinc V Coulbourn recorded skin conductance, heart rate, and respiration. Psychophysiological signals were stored on a second PC, equipped with a Scientific Solutions Labmaster DMA card, running VPM software (Cook, 1997). The psychophysiological data were analyzed using Psychophysiological Analysis (PSPHA; Declercq, Verschuere, Crombez, & De Vlieger, 2004), a software program that we developed for the off-line analysis of psychophysiological data.

Skin conductance was measured using a constant voltage (0.5 V) coupler, and Ag/AgCl electrodes (0.8 cm diameter) filled with KY jelly that were attached on the thenar and hypothenar eminences of the left hand. Skin conductance was digitized at 10 Hz. Using PSPHA, we calculated the maximal skin conductance change (with a minimum of 0.05 μS), starting between 1 and 5 s after stimulus onset (Dawson, Schell, & Filion, 2000).

Heart rate activity was obtained by a photoelectric transducer, attached to the left index finger. Heart rate was digitized at 500 Hz. PSPHA was used to detect the peaks and to calculate the distance between them. An artifact detection and correction procedure was applied with PSPHA using established procedures (Cheung, 1981). Less than 1% of the heart rate data needed editing. Prior to analysis, the interbeat intervals (IBI) were converted to heart rate in beats per minute (bpm) per real-time epoch (1 s). Mean beats per minute in the 3 s preceding stimulus onset were compared to the mean beats per minute in the 6-s period after stimulus onset.

Respiration was measured using a single strain gauge attached around the thorax. Respiration moved the air in the elastic tube and these variations were picked up by a pressure sensor. The difference in pressure was converted to voltage and digitized at 250 Hz. In line with applied research on the physiological detection of deception, we calculated respiration line length (Timm, 1982). The length of the respiration line was measured starting from stimulus onset up to 8 s later and expressed in milliseconds. Timm has pointed out that the length of the respiration line might be disproportionally affected by the start of measurement. For example, starting at the end of a slowly declining expiratory curve or at the beginning of the rapidly ascending inspiratory curve would produce different line lengths for the same time interval. To deal with this problem, each respiration line length was calculated as the mean of 10 respiration line lengths: from stimulus onset to 8 s later, from 0.1 s after stimulus onset to 8.1 s after stimulus onset, from 0.2 s to 8.2 s after stimulus onset, and so forth.

We calculated within-subject Z scores to enhance the comparability of the physiological responses between individuals. The Z scores were computed relative to the participant's mean and standard deviation (Ben-Shakhar, 1985). To further enhance comparability between response measures, we multiplied the Z scores for respiration line length and cardiac reactivity by -1, because concealed information is associated with smaller values in these measures (e.g., cardiac and respiratory suppression). In this way, larger Z scores indicated enhanced responding for all measures.

Results

Hypotheses for each dependent variable were tested using multivariate analysis of variance (MANOVA) with repeated measures treated as variates. We report percentage of variance (PV) as a measure of effect size. Following Cohen (1988), PVs of 1, 10, and 25% were used as thresholds to define small, medium, and large effects, respectively.

Skin Conductance

A 2 (stimulus: concealed vs. control information) $\times$ 2 (block: block1 vs. block2) repeated-measures MANOVA was performed to analyze the magnitude of the skin conductance response. This analysis revealed a main effect of stimulus, $F(1,22) = 20.88$, $p < .001$, $PV = .44$, confirming that skin conductance responses were larger in response to concealed information compared to control information (see Table 1). Furthermore, a significant main effect of block, $F(1,26) = 23.86$, $p < .001$, $PV = .48$, revealed that there was overall habituation from the first to the second block. The Stimulus $\times$ Block effect was not significant, $F = 1.14$.

Heart Rate

A 2 (stimulus: concealed vs. control information) $\times$ 2 (block: block1 vs. block2) MANOVA was used to analyze the heart rate data. There was a significant main effect of stimulus, $F(1,26) = 10.03$, $p < .001$, $PV = .28$. This finding revealed that the decline in heart rate was larger in response to concealed information than to control information (see Table 1). No effect with block as a factor was significant, $F\text{s} < 1.77$.

Respiration

A 2 (stimulus: concealed vs. control information) $\times$ 2 (block: block1 vs. block2) repeated-measures MANOVA was performed to analyze the length of the respiration line. As expected, the respiration line length was shorter after concealed information than after control information, $F(1,26) = 11.62$, $p < .01$, $PV = .31$ (see Table 1). No effect with block as a factor was significant, $F\text{s} < 2.17$.

Detection Efficiency

Although the present polygraph test was not primarily designed to detect concealed information at the individual level, we also

Table 1. *Means (and Standard Deviations) of the Physiological Responses to Concealed and Control Information in the Undergraduate and the Prisoners Sample; Area under the ROC Curve with Corresponding 95% Confidence Interval in Each Block*

	Block 1			Block 2		
	Concealed information mean (*SD*)	Control information mean (*SD*)	Area under the ROC curve (with 95% confidence interval)	Concealed information mean (*SD*)	Control information mean (*SD*)	Area under the ROC curve (with 95% confidence interval)
Skin conductance (μS)						
Students	0.44 (0.38)	0.19 (0.21)	.72 (.65–.79)	0.22 (0.24)	0.11 (0.22)	.66 (.59–.73)
Prisoners	0.24 (0.31)	0.10 (0.15)	.68 (.62–.74)	0.16 (0.28)	0.08 (0.15)	.60 (.54–.66)
Cardiac change (bpm)						
Students	– 2.09 (2.31)	0.24 (2.14)	.64 (.57–.72)	– 1.04 (2.01)	– 0.05 (2.02)	.55 (.47–.63)
Prisoners	– 1.15 (2.13)	0.10 (1.96)	.60 (.54–.66)	– 0.66 (1.51)	– 0.91 (2.22)	.50 (.44–.57)
Respiration line length (ms)						
Students	8358 (116)	8379 (123)	.63 (.55–.70)	8355 (94)	8367 (105)	.62 (.54–.70)
Prisoners	8405 (134)	8414 (137)	.59 (.53–.66)	8400 (137)	8416 (151)	.60 (.53–.66)

calculated the detection efficiency of the concealed information test. In line with the recommendations by the National Research Council (2003), we used an approach that was adopted from signal detection theory. We calculated a receiver operating characteristic (ROC) curve. The area under the curve (a) reflects the detection efficiency of the concealed information items across all possible cutoff points. The value of a lies between 0 and 1, with .50 indicating that the distribution from the concealed information items and the control items do not differ from each other. The area under the curve with the corresponding 95% confidence interval (Bamber, 1975) for each measure in each block can be found in Table 1. Inspection of Table 1 shows that the detection efficiency (a) was about .63 to .72 in the first block, and declined to .55 to .66 in the second block.

Discussion

Trying to conceal personal information elicits a predictable pattern of physiological reactions. Specifically, it was found that concealed information elicits a larger skin conductance response, a greater decline in heart rate, and a shortening of the respiration line length, as compared to control information. Effect sizes of the differences between concealed and control information were large for all physiological measures. The data from this pilot study therefore indicate that the present personal items concealed information test is adequate to test our main hypothesis in a less standardized (e.g., prison) situation.

MAIN STUDY

Method

Participants

Participants were 40 male prisoners of the Central State Prison Leuven (Belgium), a maximum security prison of about 250 long-term prisoners. Mean age was 39 years ($SD = 11$; range: 21–72). Eighty-five percent of the participants were of Belgian origin, with 15% of the participants having a different ethnic origin (North African: $n = 3$, and Mid-Eastern: $n = 3$). About one-third of the prisoners had a sentence between 4 and 10 years, one-third between 10 and 30 years, and one-third were convicted for life. Mean years of formal education were 10 ($SD = 2$; range 6–15 years). Participants were paid the equivalent of 1 h prison labor (2 euro).

Material

The Psychopathic Personality Inventory was used to assess psychopathic traits. Respondents indicated how much each item applied to them on a 4-point scale ranging from 1 (*false*) to 4 (*true*). Following Benning et al. (2003), we calculated the two factor scores by averaging the mean of the standardized subscale scores, because the subscales are based on a different number of items. This Z transformation ensured that the scores of the different subscales were weighted equally. The Psychopathic Personality Inventory has good to excellent psychometric properties: internal consistency and test–retest reliability of the total score are high in both undergraduates (respectively, .90 and .95; Lilienfeld & Andrews, 1996) and (female) offenders (respectively, .94 and .92; Chapman, Gremore, & Farmer, 2003). The Psychopathic Personality Inventory was translated into Dutch by four researchers, who were all experts in the domain of psychopathy (Jelicic, Merckelbach, Timmermans, & Candel, 2004). In a sample of Dutch undergraduates ($n = 127$), the Dutch translation had similar internal consistency (.92) and test–retest reliability (.99; $n = 35$) for the total score.

Procedure

The method was identical to that described in the pilot study, except that heart rate was obtained using three electrodes placed in the standard lead II configuration: The negative electrode was placed just below the right clavicle, the positive electrode on the left lower rib, and the ground electrode placed on the right lower rib. Heart rate was filtered (band pass: 8–40 Hz) and digitized at 500 Hz.

Results

Psychopathic Personality Inventory

Thirty-seven participants (92%) turned in a completed Psychopathic Personality Inventory. Internal consistency (Cronbach's alpha) in the present sample was high for the total score (.89), as well as for the Fearless Dominance factor (.84) and the Impulsive Antisocial factor (.89). Mean total score in the present sample was 350 ($SD = 40$; range: 270–428). The two factors of the Psychopathic Personality Inventory were uncorrelated, $r = .17$, $p = .32$.

Concealed Information Test

Within-subject Z scores were used for all analyses, except when analyzing the relationship of psychopathic traits and overall stimulus reactivity. Here, raw physiological responses were used, because standardization would eliminate individual differences. Again, mean Z scores were multiplied by -1 for respiratory and cardiac reactivity.

Skin Conductance

A 2 (stimulus: concealed vs. control information) × 2 (block: block1 vs. block2) repeated-measures MANOVA was performed to analyze the magnitude of the skin conductance response. This analysis revealed a main effect of stimulus, which was highly significant, $F(1,39) = 41.30$, $p < .001$, $PV = .51$. This finding demonstrated that concealed information elicited larger responses than control information did (see Table 1). Furthermore, the Stimulus × Block interaction was significant, $F(1,39) = 9.13$, $p < .01$, $PV = .19$, which indicates that the difference in skin conductance responses between concealed and control information declined from the first to the second block. Finally, the main effect of block proved to be significant, $F(1,39) = 6.58$, $p < .05$, $PV = .14$, indicating that there was an overall decline in responsivity from the first to the second block.

To compare autonomic reactivity in the prisoners' sample with the data obtained in the student sample, we pooled the data of both samples together and ran a 2 × 2 × 2 MANOVA on the electrodermal responses with stimulus and block as the within-subjects factors and group (students vs. prisoners) as the between-subjects factor. This MANOVA revealed a significant main effect of stimulus, $F(1,65) = 58.84$, $p < .001$, $PV = .47$, block, $F(1,65) = 27.40$, $p < .001$, $PV = .30$, and Stimulus × Block, $F(1,65) = 6.79$, $p < .05$, $PV = .09$. Furthermore, the Block × Group interaction effect was marginally significant, $F(1,65) = 3.42$, $p < .07$, $PV = .05$, indicating that electrodermal responding habituated faster in the student sample. No other effect with group as a factor reached significance, Fs < 1.

Heart Rate

A 2 (stimulus: concealed vs. control information) × 2 (block: block1 vs. block2) MANOVA was used to analyze the heart rate data. The main effect of stimulus was significant, $F(1,39) = 4.34$, $p < .05$, $PV = .10$, as was the Stimulus × Block interaction, $F(1,39) = 7.77$, $p < .01$, $PV = .17$. This latter finding indicated that the larger heart rate deceleration to concealed information as compared to control information in the first block disappeared in the second block (see Table 1).

A 2 × 2 × 2 MANOVA with stimulus and block as the within-subjects factors and group as the between-subjects factor was run to compare cardiac reactivity in the prisoners' sample with the data obtained in the student sample. This 2 × 2 × 2 MANOVA revealed a significant main effect of stimulus, $F(1,65) = 13.64$, $p < .001$, $PV = .17$, and of Stimulus × Block, $F(1,65) = 7.37$, $p < .01$, $PV = .10$. No effect with group as a factor reached significance, all Fs < 1.30.

Respiration

Results of the 2 (stimulus: concealed vs. control information) × 2 (block: block1 vs. block2) repeated-measures MANOVA on respiration line length showed a significant effect of stimulus, $F(1,39) = 18.11$, $p < .001$, $PV = .32$. As predicted, the length of the respiration line was shorter after concealed information as compared to control information (see Table 1). Furthermore, the main effect of block was significant, $F(1,39) = 8.65$, $p < .01$, $PV = .18$. The Stimulus × Block effect did not reach significance, $F < 1$.

A 2 × 2 × 2 MANOVA with stimulus and block as the within-subjects factors and group as the between-subjects factor was used to compare repiratory reactivity in the prisoners and the students. This analysis revealed a significant of stimulus, $F(1,65) = 28.86$, $p < .001$, $PV = .31$, and of block, $F(1,65) = 8.95$, $p < .01$, $PV = .12$. No effect with group as a factor reached significance, all Fs < 1.

Detection Efficiency

The area under the curve (a), along with 95% confidence intervals, for each measure in each condition can be found in Table 1. As can be seen in Table 1, detection efficiency (a) was about .59 to .68 in the first block, and declined to .50 to .60 in the second block. A comparison of the detection efficiency in students and prisoners shows that detection efficiency is slightly smaller in the prisoners sample, but not significantly so.

Psychopathic Traits and the Concealed Information Test

First, we examined whether psychopathic traits were related to overall stimulus reactivity. We therefore calculated Pearson's r between the Psychopathic Personality Inventory factor scores and the mean (raw) response of each participant on each dependent measure. To reduce the number of analyses and because correlations per block were nearly identical to the overall correlations, we calculated the correlations across blocks. Inspection of Table 2 reveals that the Impulsive Antisociality factor of the Psychopathic Personality Inventory correlated significantly negatively with skin conductance reactivity, $r = -.37$, $p < .05$. Antisocial prisoners thus showed reduced overall electrodermal reactivity, indicative of autonomic underarousal. No other significant correlations were found.

Second, we examined whether psychopathic traits were related to differential reactivity in the concealed information test. We therefore calculated Pearson's r between the Psychopathic Personality Inventory factor scores and the concealed information effect measure (the mean standardized response to the concealed information minus the mean standardized response to the control information). Inspection of Table 2 reveals that the Impulsive Antisociality factor correlated negatively with all three response measures, all $r < -.18$, and that the relationship with skin conductance reached statistical significance, $r = -.34$, $p < .05$ (see Figure 1). All correlations with the fearless

Table 2. *Correlations between Psychopathic Personality Inventory (PPI) Factor Scores and Overall Stimulus Reactivity and the Effect of Concealed Information*

	Overall stimulus reactivity		Concealed information effect	
	PPI-I	PPI-II	PPI-I	PPI-II
Skin conductance	.15	−.37*	.04	−.34*
Cardiac change	.20	.14	.01	−.21
Respiration line length	−.07	−.11	.18	−.19

Notes. Signs have been reversed for cardiac and respiratory reactivity, so that a negative correlation indicates reduced reactivity for all measures. PPI-I: the Fearless Dominance factor of the Psychopathic Personality Inventory; PPI-II: the Impulsive Antisociality factor of the Psychopathic Personality Inventory.
*$p < .05$; **$p < .01$.

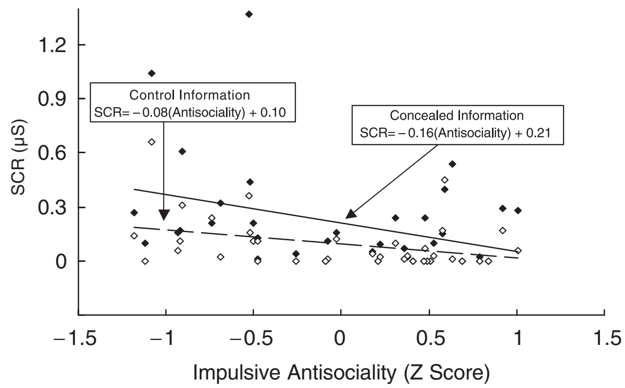

Figure 1. Scatterplot, prediction lines, and prediction equations for the relationship between Impulsive Antisociality and skin conductance responses (in microSiemens) separately for concealed information (closed diamonds) and control information (open diamonds).

Dominance factor of the Psychopathic Personality Inventory were close to zero.

General Discussion

Autonomic Responding to Concealed Information in a Prison Sample

A concealed information polygraph test was performed in a sample of male inmates of a high security prison. As expected, concealed information elicited enhanced orienting responses compared to control information. This finding replicates and extends previous research (Lieblich, Ben-Shakhar, & Kugelmass, 1976), which demonstrated that responding to concealed information in male prisoners is comparable to responding in undergraduates. Our study differs in two important aspects from this earlier research. First, examining basic autonomic responding, we used an equal proportion of concealed and control information in order to prevent a confound between novelty and significance (see Dawson et al., 2000). Second, whereas Lieblich et al. only used skin conductance, we also measured respiratory and cardiac responding. As a global measure of arousal, skin conductance does not give insight into the underlying mechanism of the concealed information test. Cardiac and respiratory responding, on the other hand, allow a test of whether orienting responses account for the enhanced responding. Specifically, orienting is accompanied by a decline in heart rate and respiratory suppression (Lynn, 1966). As predicted from the orienting hypothesis, concealed information elicited greater cardiac decline and greater respiratory suppression compared to control information. The present data showed that enhanced orienting underlies the concealed information test in both the undergraduate and the prison sample. By demonstrating that the pattern of physiological responding in the prison sample was similar to responding in the undergraduate sample, our study provides good evidence for the external validity of the concealed information test.

Psychopathy and Physiological Detection of Deception

Our results further demonstrate that antisocial inmates display reduced electrodermal responding to concealed information. This finding is consistent with the results of two experiments by Waid and colleagues (1979a, 1979b), who also observed reduced skin conductance responding to concealed information in low socialized undergraduates (but see Balloun & Holmes, 1979; Gudjonsson, 1982). Raskin and Hare (1978) noted that lack of responding to concealed information results in a truthful outcome (e.g., a false negative outcome). The electrodermal hyporesponsiveness in antisocial individuals might therefore threaten the validity of the concealed information test, particularly because the electrodermal measure is the most sensitive index of concealed information (Ben-Shakhar & Furedy, 1990). The reduced responding could imply that profoundly antisocial individuals have a greater chance of escaping detection. Notably, field research with the concealed information test (Elaad, 1990; Elaad, Ginton, & Jungman, 1992) has found a higher percentage of false negatives compared to laboratory research. This has been attributed to the fact that these field studies were not optimally designed in that they used a lower number of concealed information questions. The present data, however, lead us to speculate that the increased percentage of false negatives could partly be due to a number of antisocial offenders that passed the polygraph test. Future field research could include a measure of psychopathy in order to examine this possibility.

Given that physiological responses to concealed information are related to the orienting reflex, reduced orienting seems to account for the present findings. Reduced skin conductance orienting in antisocial/psychopathic individuals is a well-known finding in psychophysiology (for a recent review, see Lorber, 2004). For example, compared to nonpsychopaths, psychopaths show reduced skin conductance responding to punishment cues (e.g., Arnett, Smith, & Newman, 1997), and to emotional pictures (e.g., Herpertz et al., 2001). This fits well with the theory by Eysenck (1964), who reasoned that the psychopath is in a chronic state of underarousal, and therefore in need for stimulation in order to optimize the arousal level. This may explain why psychopaths are quickly bored, impulsive, and thrill seeking. Antisocial acts, then, are regarded as a deviant form of stimulation seeking. Raine (1997) has demonstrated that this underarousal is mainly related to the impulsive antisociality facet of psychopathy. Likewise, we found that the reduced skin conductance reactivity in the concealed information test was related to the Impulsive Antisociality factor of the Psychopathic Personality Inventory.

Limitations and Conclusions

The present study is not without its limitations. First, psychopathic personality traits were assessed using a self-report measure, which may be biased by response tendencies. Akin to this concern is the fact that the mean total scores in the present prison sample ($M = 350$, $SD = 40$) were not particularly higher than those observed in undergraduates (e.g., $M = 344$, $SD = 39$; Jelicic et al., 2004). Chapman et al. (2003) have reported a similar finding, in that they observed similar mean total scores in a normal female sample and a sample of female prisoners. This issue definitely needs further examination. Second, at least two alternative explanations could account for the reduced responding in antisocial prisoners. One possibility is that personal names may be less significant for antisocial individuals. Another possibility is that the antisocial prisoners answered deceptively on the questionnaire about their personal names. Future research could resolve these issues by (a) assessing the significance of the personal names prior to the concealed information test or by using other variants of the concealed information paradigm (e.g., mock crime), and (b) by checking the self-reported information through objective resources, such as file information.

Despite these limitations, two main conclusions emerge from the present data. First, orienting accounts for the concealed information effect in both undergraduates and prisoners. The present data therefore support the test theory (construct validity) of the concealed information test and provide evidence for its external validity. Second, our study also highlights the importance of assessing personality variables, such as psychopathic traits, which may moderate responding to concealed information.

REFERENCES

Arnett, P. A., Smith, S. S., & Newman, J. P. (1997). Approach and avoidance motivation in incarcerated psychopaths during passive avoidance. *Journal of Personality and Social Psychology*, *72*, 1413–1428.

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.

Bamber, D. (1975). The area above the ordinal dominance graph and the area below the receiver operating characteristic graph. *Journal of Mathematical Psychology*, *12*, 387–415.

Benning, S. D., Patrick, C. J., Bloningen, D. M., Hicks, B. M., & Iacono, W. G. (in press). Estimating facets of psychopathy from normal personality traits: A step towards community-epidemiological investigations. *Assessment*.

Benning, S. D., Patrick, C. J., Hicks, B. M., Bloningen, 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. (1985). Standardisation within individuals: A simple method to neutralize individual differences in psychophysiological responsivity. *Psychophysiology*, *22*, 292–299.

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., & Furedy, J. (1990). *Theories and applications in the detection of deception*. New York: Springer-Verlag.

Chapman, A. L., Gremore, T. M., & Farmer, R. F. (2003). Psychometric analysis of the Psychopathic Personality Inventory (PPI) with female inmates. *Journal of Personality Assessment*, *80*, 164–172.

Cheung, M. N. (1981). Detection of and recovery from errors in cardiac interbeat intervals. *Psychophysiology*, *18*, 341–346.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. San Diego, CA: McGraw-Hill.

Cook, E. W., III. (1997). *VPM reference manual*. Birmingham, AL: Author.

Dawson, M. E., Schell, A. M., & Filion, D. L. (2000). The electrodermal system. In J. T. Cacioppo, L. G. Tassinary, & G. B. Berntson (Eds.), *Handbook of psychophysiology* (pp. 200–223). New York: Cambridge University Press.

Declercq, A., Verschuere, B., Crombez, G., & De Vlieger, P. Psychophysiological Analysis [PSPHA]. [Computer software]. Ghent University. Submitted for publication.

Elaad, E. (1990). Detection of guilty knowledge in real-life criminal investigations. *Journal of Applied Psychology*, *75*, 521–529.

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.

Gough, H. G. (1956). *California psychological inventory*. Palo Alto, CA: Consulting Psychologists Press.

Gudjonsson, G. H. (1982). Some psychological determinants of elctrodermal responses to deception. *Personality and Individual Differences*, *3*, 381–391.

Hare, R. D. (1991). *The Hare psychopathy checklist–revised*. Toronto: Multi-Health Systems.

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., Werth, U., Lucas, G., Qunabi, M., Schuerkens, A., & Kunert, H. J., et al. (2001). Emotion in criminal offenders with psychopathy and borderline personality disorder. *Archives of General Psychiatry*, *58*, 737–745.

Honts, C. R., Raskin, D. C., & Kircher, J. C. (1985). Effects of socialization on the physiological detection of deception. *Journal of Research in Personality*, *19*, 373–385.

Jelicic, M., Merckelbach, H., Timmermans, M., & Candel, I. (2004). De Nederlandstalige versie van de Psychopathic Personality Inventory: Enkele psychometrische bevindingen [The Dutch Version of the Psychopathy Personality Inventory: Some psychometric results]. *De Psycholoog*, *12*, 604–608.

Lieblich, I., Ben-Shakhar, G., & Kugelmass, S. (1976). Validity of the guilty knowledge technique in a prisoner's sample. *Journal of Applied Psychology*, *61*, 89–93.

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 agression, psychopathy, and conduct problems: A meta-analysis. *Psychological Bulletin*, *130*, 531–552.

Lykken, D. T. (1959). The GSR in the detection of guilt. *Journal of Applied Psychology*, *43*, 385–388.

Lykken, D. T. (1974). Psychology and the lie detector industry. *American Psychologist*, *29*, 725–739.

Lykken, D. T. (1978). The psychopath and the lie detector. *Psychophysiology*, *15*, 137–142.

Lynn, R. (1966). *Attention, arousal and the orientation reaction*. Oxford: Pergamon Press.

MacLaren, V. (2001). A quantitative review of the Guilty Knowledge test. *Journal of Applied Psychology*, *86*, 674–683.

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., & Iacono, W. (1989). Psychopathy, threat, and polygraph test accuracy. *Journal of Applied Psychology*, *74*, 347–355.

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.

Raskin, D., & Hare, R. D. (1978). Psychopathy and detection of deception in a prison sample. *Psychophysiology*, *15*, 126–136.

Sokolov, E. N. (1963). *Perception and the conditioned reflex*. New York: Macmillan.

Timm, H. W. (1982). Analyzing deception from respiratory patterns. *Journal of Police Science and Administration*, *10*, 47–51.

Verschuere, B., Crombez, G., Declercq, A., & Koster, E. H. W. (2004). Autonomic and behavioral responding to concealed information: Differentiating orienting and defensive responses. *Psychophysiology*, *41*, 261–266.

Waid, W. M., Orne, M. T., & Wilson, S. K. (1979a). Effects of socialization on electrodermal detection of deception. *Psychophysiology*, *16*, 15–22.

Waid, W. M., Orne, M. T., & Wilson, S. K. (1979b). Socialization, awareness, and the electrodermal response to detection of deception and self disclosure. *Journal of Abnormal Psychology*, *88*, 663–666.

(Received June 4, 2004; Accepted December 20, 2004)