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Psychopathy and Detection of Deception In a Prison Population

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ABSTRACT

The effectiveness of detection of deception was evaluated with a sample of 48 prisoners, half of whom were diagnosed psychopaths. Half of each group were "guilty" of taking $20 in a mock crime and half were "innocent." An examiner who had no knowledge of the guilt or innocence of each subject conducted a field-type interview followed by a control question polygraph examination. Electrodermal, respiration, and cardiovascular activity was recorded, and field (semi-objective) and quantitative evaluations of the physiological responses were made. Field evaluations by the examiner produced 88% correct, 4% wrong, and 8% inconclusives. Excluding inconclusives, there were 96% correct decisions. Using blind quantitative scoring and field evaluations, significant discrimination between "guilty" and "innocent" subjects was obtained for a variety of electrodermal, respiration, and cardiovascular measures. Psychopaths were as easily detected as nonpsychopaths, and psychopaths showed evidence of stronger electrodermal responses and heart rate decelerations. The effectiveness of control question techniques in differentiating truth and deception was demonstrated in psychopathic and nonpsychopathic criminals in a mock crime situation, and the generalizability of the results to the field situation is discussed.

DESCRIPTORS: Detection of deception, Heart rate, Polygraph tests, Psychopathy, Respiration, Skin conductance, Skin potential, Vasomotor response.

Although many investigators have carried out research on detection of deception with criminals and criminal suspects (e.g., Bersh, 1969; Kugelmass, Lieblich, Ben-Ishai, Opatowski, & Kaplan, 1968; Luria, 1932; Lykken, 1955; Marston, 1921; Raskin, Barland, & Podlesny, 1977), there is little evidence on the relationship between psychopathy and the effectiveness of detection of deception techniques. However, there is laboratory evidence that psychopathic (or sociopathic) criminals are electrodermally hyporeactive under some experimental conditions (Hare, 1978). On the basis of such findings and the commonly-held belief that psychopaths are very adept at manipulating and deceiving others (e.g., Clancy, Noyes, & Travis, 1974; Cleckley, 1964), there are frequent claims that psychopaths can "beat" the polygraph test (Barland & Raskin, 1973; Ferguson & Miller, 1974; Floch, 1950; Levitt, 1955).

The possibility that psychopaths may be able to defeat the polygraph test is suggested by the fact that they appear to be electrodermally hyporesponsive to intense, noxious, or painful stimuli or to the anticipation of such stimuli (Hare, 1978). If the stimuli presented in a polygraph test are of such a nature and only electrodermal measures are ob-

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tained, then it might be the case that deceptive psychopaths would show relatively weak electrodermal responses to the questions and be able to escape detection. That outcome might occur in polygraph tests where lack of responsiveness to the stimuli is taken as an indication of truthfulness, such as with the relevant-irrelevant and guilty knowledge tests (Podlesny & Raskin, 1977). However, the design of the control question test (Podlesny & Raskin, 1977) attempts to protect against such problems of hyporesponsivity by requiring that reactions occur with greater strength to control questions (see Method section) before a truthful judgment can be rendered. The major purpose of the present study was to assess the extent to which the control question test is effective in detecting deception with psychopaths when standard measures of respiration and cardiovascular activity are included along with electrodermal activity.

There are only two published scientific studies which have used psychopaths in a detection of deception situation. As part of a laboratory study using tones and electric shocks, Lykken (1955) required subjects to choose a number between 1 and 5 and then conceal the number by answering "no" when asked about the number. Nonpsychopathic criminals and noncriminal subjects produced larger electrodermal responses to the chosen number, but psychopathic criminals showed large reactions to all numbers. Since the Lykken study did not use current polygraph examination techniques and it employed only electrodermal measures, little can be concluded with regard to the detectability of psychopaths.

Raskin et al. (1977) examined criminal suspects using control-question polygraph techniques. Individuals had been referred by prosecutors, law enforcement agencies, and defense counsel for examination concerning the crime of which they were accused. Guilt or innocence was assessed by a panel of experts consisting of two defense attorneys, two prosecutors, and a judge. They made independent judgments based on all of the evidence, disregarding legal technicalities and without any knowledge of the polygraph results. Of the 36 subjects considered to be guilty by a majority of the panel, psychopaths and nonpsychopaths were identified using the Pd scale of the Minnesota Multiphasic Personality Inventory (MMPI). The 14 subjects with the highest T-scores (mean $T=85.4$) were designated psychopathic, and the 12 lowest scorers (mean $T=50.3$) were designated nonpsychopathic. There were no significant differences in overall reactivity for the two groups, and all of those diagnosed as psychopathic produced deceptive results.

There are two problems in the interpretation of the Raskin et al. results. First, the relationship between MMPI scores or profiles and the clinical conception of psychopaths has not yet been adequately specified (Hare & Cox, 1978), and research is needed using subjects selected on the basis of stringent clinical criteria. Second, the study was based on the results of field polygraph examinations in which there was some uncertainty about whether or not the subject was guilty (ground truth). Although all of the psychopathic subjects produced deceptive outcomes, it is desirable to have the certain knowledge of ground truth that is provided by a laboratory experiment.

The present study attempted to rectify the problems inherent in the Lykken (1955) and Raskin et al. (1977) studies. A control-question test of the type employed by many field polygraph examiners (Barland & Raskin, 1973) was administered by a trained polygraph examiner to subjects in a mock-crime situation which attempted to simulate the field situation. In addition to electrodermal measures, cardiovascular and respiratory activity were recorded. The subjects were drawn from a prison population, and a clinical assessment procedure was utilized to categorize subjects as psychopathic or nonpsychopathic. On the basis of those procedures, we felt that the outcome would provide a reasonable estimate of the extent to which psychopaths can be detected in deception by means of physiological measures and field polygraph techniques.

Method

Subjects

Subjects were obtained from the inmate population of the Lower Mainland Regional Correctional Centre in Burnaby, British Columbia. Inmates volunteered for a "lie-detection" study in which they could win a $20 bonus for successful performance. The subjects were divided into psychopathic and nonpsychopathic groups on the basis of procedures similar to those used in a series of studies by Hare and his colleagues (Hare & Cox, 1978).

Each potential subject's file was obtained from the records center at the prison. The information consisted of reports by correction officers, parole officers, physicians, psychiatrists, psychologists, and social workers, as well as background information sheets, criminal records, court transcripts, law enforcement and inmate versions of the offenses, parole applications, and daily log sheets. Using this information, a trained and experienced researcher rated each subject on a 7-point scale of psychopathy. The ratings were made on the basis of the degree to which the inmate's behavior over a long period of time was consistent with the conception of psychopathy outlined by Cleckley (1964). Although based on a global assessment of psychopathy, these procedures are reliable when experienced raters are used. In general, inter-rater reliability coefficients in the .75 to .90 range have been obtained (Chesno & Kilmann, 1975; Dengerink & Bertilson, 1975; Hare & Cox, 1978). In the present study, subjects with a rating of 6 or 7 were defined as psychopaths, while those with ratings of 1 or 2 were considered to be nonpsychopaths. Since recent evidence (Hare, 1978) indicates that measures of socialization may be useful in identifying psychopaths when case history information is limited, a measure of socialization was also employed.

Four subjects were discarded because of initial problems with the instructions and question structure, one was actively psychotic, and one failed to conceal the $20 properly. The remaining subjects consisted of 24 psychopaths (mean age = 23.1 yrs) and 24 nonpsychopaths (mean age =26.5 yrs). Half of each group was randomly assigned to the "guilty" condition, and half was assigned to the "innocent" condition. Within each combination of guilt and psychopathy, the 12 subjects were divided into low and high socialization subgroups by means of their scores on the Socialization (*So*) scale of the California Psychological Inventory (Gough, 1969).

Procedure

When a subject arrived for the experiment, he was met by an assistant who explained the nature of the experiment and administered a number of psychological tests including the *So* scale. Then the assistant flipped a coin to determine whether the subject would be in the "guilty" or "innocent" condition. If the subject was in the "guilty" condition, he was told that there was a $20 bill in an envelope in a drawer in a nearby room. That room was normally off-limits to inmates, and a prison guard was stationed outside the door. The subject was instructed to obtain the $20 bill from the envelope when no one was observing him and to hide it in his pocket. He was informed that he would be taken to another room and be given a lie detector test concerning the $20. He was instructed to deny having taken the $20; and if he succeeded in being cleared by the polygraph test, he would win the $20. The "innocent" subjects were informed about the "crime" committed by the "guilty" subjects, and they were also instructed to deny having taken the money. If they successfully demonstrated their truthfulness, they also received a $20 bonus. Thus, all subjects were instructed to deny having taken the money, and all subjects who produced truthful polygraph charts received a $20 bonus. The $20 represented a considerable sum of money to the subjects, since they earned $.75/day for working at a prison job and had no other obvious sources of income.

The subject was then taken to the examination room, where a psychophysiologist (the senior author) trained in field polygraph techniques administered a control-question polygraph examination. The examiner did not know whether the subject was "guilty" or "innocent," or if he was psychopathic. The examination consisted of a pretest interview followed by physiological recordings obtained during the test phase. During the pretest interview the examiner obtained biographical information from the subject, reviewed the questions with the subject, and explained the physiological measures to be obtained and the theory underlying the use of the polygraph for detecting deception.

The polygraph test was a control question test similar to that employed by Barland and Raskin (1975). It consisted of 10 questions including relevant questions at positions 5, 7, and 10 and control questions at positions 4, 6, and 9. All of the questions except the control questions were the same for each subject. The control questions were adjusted to fit each individual, and their wording was worked out with the subject prior to administering the test so that the subject would answer "no" to all control and relevant questions (see Podlesny & Raskin, 1977, for a more complete description of the theory underlying control question tests). A typical question sequence was as follows:

1. Were you born in Canada?
2. Regarding that $20, do you intend to answer truthfully each question about that?
3. Are you completely convinced I will not ask a question that hasn't been reviewed?
4. Other than what you told me, before you were 18 did you ever steal any money?
5. Did you take that $20?
6. Did you ever steal anything else from someone who trusted you?
7. Did you take that $20 from the drawer?
8. Is your last name ____________?
9. Have you ever taken anything of value from an employer?
10. Do you have that $20 now?

Prior to the polygraph test with the above questions, the subject was attached to the polygraph and a number test was conducted in order to adjust the instrument and to demonstrate the effectiveness of the technique to the subject. He was asked to choose a number between 3 and 6, and the number was written on a card and taped on the wall directly in front of where he was seated. He was then told that he would be asked about the number that he had chosen and that he was to answer "no" to all of the questions. During the test the subject was seated facing away from the examiner and the polygraph, and both subject and examiner observed the card with the number on it. The examiner then asked a series of questions about the numbers 1 through 7. Following the number test, the subject was informed that everything was working well and that the results showed a large reaction to the number he had chosen and very little reaction to the other numbers. The subject was then told that the test indicated how his reactions appeared when he was lying and when he was telling the truth, and he was told that he had nothing to worry about as long as he truthfully answered every question on the polygraph test.

The polygraph test concerning the $20 was then administered. It consisted of a minimum of three charts obtained while the 10 questions were asked at a rate of one every 25–35 sec. If the results were not obvious after the third chart, additional charts were obtained up to a maximum of seven charts. If more than three charts were obtained, the fourth chart was a silent answer test in which the subject was instructed to answer silently to himself (Horvath & Reid, 1972).

Following each chart, the examiner asked the subject if any questions bothered him and if he would like to change the wording of any question. The attention of all subjects was directed toward the control questions, and it was often necessary to modify the specific wording of one or more control questions following admissions or expressions of concern by the subject. The wording of the relevant questions was never modified. Prior to each chart the subject was cautioned to tell the truth in answering every question. He was told that if he lied to any question, there would be reactions on the chart. That procedure was designed to focus the concern of "innocent" subjects on the control questions and to enhance the concern of "guilty" subjects with regard to the relevant questions. After the last chart had been obtained, a field-type numerical evaluation of the charts was performed by the examiner (Barland & Raskin, 1975), and a decision was made on the basis of that score as described below.

Apparatus

A Beckman Type R Dynograph was used to record the physiological activity at a chart speed of 2.5mm/sec. The amplitude of recordings was adjusted to provide pen excursions of approximately 1.5–3 cm in most cases. Thoracic and abdominal respiration measures were obtained from pneumatic tubes positioned around the upper thorax and abdomen. Each pneumatic tube was attached to a Grass PT5A Volumetric Pressure Transducer, and the signal from that was fed into a Beckman 9853A Voltage/Pulse/Pressure coupler. Skin conductance (SC) was obtained from electrodes placed on the thenar and hypothenar eminences of the left hand and connected to a Beckman 9842 Galvanic Skin Response Coupler, which imposed .5V across the electrodes. The recordings were made using a 22-sec time constant. Skin potential (SP) was obtained from an active electrode placed on the thenar eminence of the right hand and an inactive electrode positioned approximately 4 cm below the elbow on the volar surface of the forearm. The skin beneath the inactive site was vigorously rubbed with an alcohol-dampened, coarse tissue until a local erythema was produced. A time constant of 17 sec was utilized. Cardiac activity was measured from electrodes attached to the right wrist and left ankle (EKG Lead II) and connected to a Beckman 9857 Cardiotachometer Coupler. The heart rate (HR) output was sampled on a sec-by-sec basis using a PDP 8/E online computer. All of the electrodes were Beckman Biopotential filled with .05M NaCl in a cornstarch paste and attached with Beckman adhesive collars. Prior to electrode application each site was cleaned with 95% ethanol. Vasomotor activity was recorded from the left thumb using a photoelectric plethysmograph containing a Fairchild FPA 104 transducer, which consists of a light-emitting diode and a phototransistor. The transducer was placed in an aluminum cylinder and attached by means of an adhesive collar and masking tape. The signal was fed into a Beckman 9874 Photocell Coupler. Finger pulse amplitude (FPA) was obtained by recording the signal with a .1-sec time constant, and finger blood volume (FBV) was recorded with a 20-sec time constant.

Quantification of the Data

There were two types of evaluations made on the charts. The first consisted of on-the-spot, numerical evaluations similar to those reported by Barland & Raskin (1975). The criteria included only those responses which have been demonstrated to discriminate between truth and deception in laboratory studies (Podlesny & Raskin, 1977). Specifically, the following criteria were used in scoring responses: Respiration—sustained decreases in amplitude, slowing of rate, increases in baseline, apnea; Skin Conductance—increase in SC, multiple responses, increased duration of response; Cardiovascular—decrease in FBV, decrease in FPA, slowing of HR.

Using the above criteria, the responses to control and relevant questions were compared for each type of measure (respiration, skin conductance, cardiovascular) on each chart. The responses to adjacent pairs of control and relevant questions (4–5, 6–7, 9–10) were compared, and a number ranging from +3 to −3 was assigned to each pair for each type of measure on each chart. The sign and size of each such score was determined according to the relative magnitudes of the responses to the control and relevant question in each pair. If the response to the control question was larger, then a positive score was assigned; if the response to the relevant question was larger, a negative score was assigned; and a zero was assigned if there was no difference between the two responses. Whether the response was assigned a value of 1, 2, or 3 was determined by criteria used by the United States Army Military Police School (Note 1). Total scores for the first three charts and for all charts were obtained by summing the scores over question pairs, charts, and measures. If the total score for the first three charts was +6 or higher, the subject was judged to be truthful; if it was −6 or lower, the subject was judged deceptive; and a score between ±5 was considered inconclusive. If the score for the first three charts was inconclusive, the scores from additional charts were utilized to attempt to arrive at decisions for those subjects. That was done for 8 subjects (1 "innocent" psychopath, 3 "guilty" nonpsychopaths, and 4 "innocent" nonpsychopaths).

The second type of analysis of the charts consisted of an objective quantification of responses by a technician who had no knowledge of the field evaluations or the treatments administered to the subjects. Measurements were made on the responses to each of the three control and three relevant questions on the first three charts obtained from each subject. The following scores were obtained for each of those 18 observations:

1. *Thoracic Respiration Amplitude (TRA)*. The amplitude in mm of the last full inspiration preceding the beginning of the question was subtracted from the amplitude of the first complete inspiration following the answer to the question. This provided an index of change in RA, with negative scores indicating decreases in RA and positive scores indicating increases in RA.

2. *Abdominal Respiration Amplitude (ARA)*. Scores for this measure were obtained from the abdominal tracing in the same manner as those described for TRA.

3. *Respiration Cycle Time (RCT)*. The distance in mm between the points of maximum inspiration for the two respiration cycles preceding the onset of the question was subtracted from the distance between the points of maximum inspiration for the two cycles following the answer to the question. This provided an index associated with change in rate of respiration, with positive scores indicating slowing of respiration and negative scores indicating speeding.

4. *Thoracic Respiration Baseline (TRB).* Deviations in mm in the baseline were obtained by subtracting the baseline at the onset of inspiration for the last complete inspiration preceding the beginning of the question from the baseline of each of the next five cycles following question onset, excluding the artifacts due to the subject's answer. Positive scores indicated rises in respiration baseline, and negative scores indicated drops in respiration baseline.

5. *Abdominal Respiration Baseline (ARB).* These were obtained from the abdominal tracing in the same manner as described for TRB.

6. *Skin Conductance Response (SCR).* The increase in mm was measured from the onset of the first increase within 1 sec after the beginning of the question to the highest point reached within 5 sec after the answer. The scores were also converted to μmhos. Since the scores expressed in mm yielded slightly more reliable results, they are the only ones reported here.

7. *Skin Potential Response (SPR).* The change in mV was measured from the onset of the first wave within the period beginning 1 sec after question onset and ending 5 sec after the answer. If the first wave was a negative wave which was followed by a positive wave, then the change in mV of the positive wave was measured from the highest point reached by the negative wave. Only waves which reached their peak within 3 sec following their onset were considered to be positive waves. That procedure was used to eliminate scoring as positive waves the simple recovery toward baseline following a negative wave (Raskin, Kotses, & Bever, 1969).

8. *Finger Blood Volume (FBV).* The decrease in mm of the diastolic level of the tracing was measured from the highest point within the 4 sec following the onset of the question to the lowest point within 4–14 sec following question onset. Since there was a very large range of gain settings across subjects, all scores were corrected to a common gain.

9. *Finger Pulse Amplitude (FPA).* The decrease in FPA was obtained by calculating the difference in mm of the sum of the amplitudes of the two largest adjacent pulses within 4 sec after the onset of the question and the sum of the amplitude of the two smallest adjacent pulses within 4–14 sec after the onset of the question. These values were also corrected to a common gain.

10. *Heart Rate (HR).* Changes in HR were measured in bpm by subtracting the mean HR for the 3 sec preceding question onset from the HR for each of the 20 sec following question onset.

Results[1]

Numerical Evaluations

Accuracy of Decisions. Using an inconclusive region of ±5 inclusive, the outcomes were assessed on the basis of the total score for the first three charts and for all charts. Table 1 shows the results for "guilty" and "innocent" subjects and for psychopaths and nonpsychopaths. Using only three charts, categorizations were 81% correct, 2% wrong, and 17% inconclusive. Excluding inconclusives, the accuracy rate was 98%. When additional charts were used, 88% were correctly categorized, 4% were wrong, and 8% were inconclusive. Excluding inconclusives, the accuracy rate was 96%.

Although there were only 2 errors, both of them were false positives, i.e., "innocent" subjects whose polygraph charts indicated deception. With regard to psychopathy, one of the errors occurred with a psychopathic subject and one with a nonpsychopath. It should be noted that no "guilty" subject was able to produce a truthful result. There were no significant differences in accuracy rates for psychopaths and nonpsychopaths.

Using the total score for all charts, a *post facto* manipulation of the cut-offs of the inconclusive region was made for boundaries ranging from zero to ±12, and the results are shown in Fig. 1 in terms of percent accuracy of decisions and percent inconclusives for the "guilty" and "innocent" groups. When the inconclusive region was limited to scores of zero, 96% of the "guilty" subjects and 88% of the "innocent" subjects were correctly categorized, and there were no inconclusives. With boundaries of ±2 there was maximal accuracy of decisions combined with a relatively low rate of inconclusives. As the boundaries of the inconclusive region were widened, there was no improvement in accuracy of decisions and the percent of inconclusive cases eventually increased dramatically. It appears that the optimal boundaries are somewhere in the region of ±2 to ±4. At any

TABLE 1

Examiner decisions based on total numerical scores for the first 3 charts and for all charts

Charts	Groups	Examiner Decisions		
		Deceptive	Truthful	Inconclusive
First 3	"Guilty"	21	0	3
	"Innocent"	1	18	5
All	"Guilty"	21	0	3
	"Innocent"	2	21	1
		Correct	**Wrong**	**Inconclusive**
First 3	Psychopaths	22	1	1
	Nonpsychopaths	17	0	7
	Combined	39	1	8
All	Psychopaths	23	1	0
	Nonpsychopaths	19	1	4
	Combined	42	2	4

[1] All statistical tests employed a .05 rejection region.

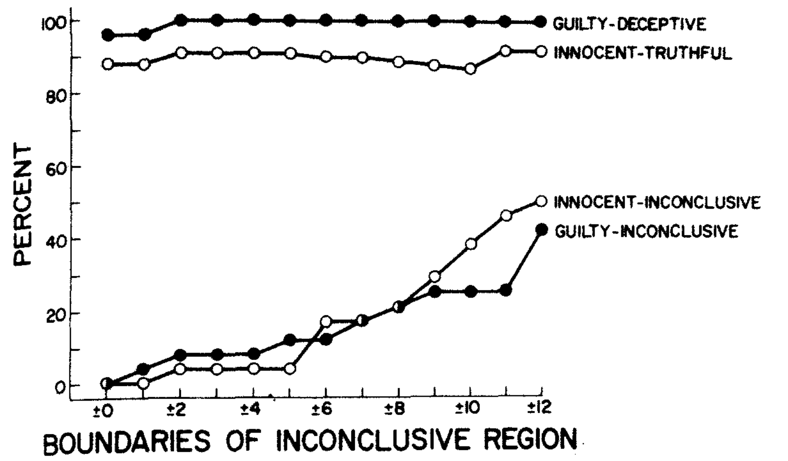

Fig. 1. Accuracy of decisions and percent inconclusives for different inconclusive regions.

point in that region there were no false negatives, 4.2% false positives, and 6.2% inconclusives.

Effectiveness of Numerical Scores. Since all subjects had at least three charts, the total numerical scores for the first three charts were compared for "guilty" and "innocent" subjects using the four combinations of psychopathy and socialization. The mean scores for those groups are shown in Table 2. Analysis of variance indicated that the mean scores of −11.1 for all "guilty" subjects and +9.4 for all "innocent" subjects produced reliable discrimination between those conditions ($F(1/40)=83.21$, $MS_e=60.85$). There was no reliable difference in the magnitude of scores for psychopaths and nonpsychopaths ($F<1$), nor was there any difference in the magnitude of scores for "guilty" and "innocent" subjects ($F<1$). However, low socialization subjects showed significantly higher magnitude of scores than high socialization subjects ($F(1/40)=6.96$, $MS_e=52.97$). Thus, psychopaths and nonpsychopaths showed equally appropriate responses, the numerical system identified "guilty" and "innocent" subjects with equal power, but differentiation between "guilty" and "innocent" subjects was better for low socialization as compared to high socialization subjects.

Physiological Measures. The scores for each of the three types of physiological measures were summed over the first three charts, and the mean total scores for "guilty" and "innocent" subjects within the four combinations of psychopathy and socialization are shown for each measure in Table 2. The mean total scores for respiration showed significant discrimination between "guilty" and "innocent" subjects ($F(1/40)=63.34$, $MS_e=8.42$), as did the mean total scores for skin conductance ($F(1/40)=41.83$, $MS_e=25.89$) and cardiovascular ($F(1/40)=25.37$, $MS_e=8.88$). There was a significant interaction between "Guilty-Innocent" and physiological measures ($F(2/80)=7.08$, $MS_e=11.35$), and a Newman-Keuls test showed that the skin conductance measure produced better discrimination between "guilty" and "innocent" subjects than did the respiration and cardiovascular measures, and the respiration measure produced better discrimination than the cardiovascular measure. Furthermore, the respiration measure identified "innocent" subjects significantly better than "guilty" subjects ($F(1/40)=5.70$). The only significant effects related to psychopathy or socialization were found with the cardiovascular measure. A significant Socialization × "Guilty-Innocent" interaction ($F(1/40)=5.86$) indicated that high socialization-"innocent" subjects showed no differentiation between control and relevant questions on the cardiovascular measure.

TABLE 2

Mean scores for each measure and total scores for the first 3 charts

Measures	Groups	Mean Scores				
		Psychopaths		Nonpsychopaths		Combined
		Low *So*	High *So*	Low *So*	High *So*	
Respiration	"Guilty"	−2.5	−2.5	−2.5	−1.8	−2.3
	"Innocent"	+6.7	+2.3	+4.7	+3.7	+4.3
Skin Conductance	"Guilty"	−7.2	−6.2	−6.7	−3.0	−5.8
	"Innocent"	+3.5	+5.8	+5.5	+0.2	+3.8
Cardiovascular	"Guilty"	−5.0	−2.8	−2.3	−1.8	−3.0
	"Innocent"	+1.5	−0.5	+4.0	+0.3	+1.3
Total Score	"Guilty"	−14.7	−11.5	−11.5	−6.7	−11.1
	"Innocent"	+11.7	+7.7	+14.2	+4.2	+9.4

Quantitative Analyses

The first three polygraph charts for each subject were analyzed using the procedures previously described, and each of the dependent variables was subjected to analysis of variance. Using the control question technique, discrimination between "guilty" and "innocent" subjects would be indicated by a significant interaction between "Guilty-Innocent" and Question Type. That prediction is based on the principle that deceptive subjects should show larger responses to the relevant questions and truthful subjects should respond more strongly to the control questions.

The mean responses to the control and relevant questions for "guilty" and "innocent" subjects are shown for several dependent variables in Table 3. The predicted interactions were obtained for all dependent variables except respiration cycle time. The results of the F tests on the interactions are presented in Table 3, and details of the results for the various physiological measures are described below. Except as noted below, there were no differential effects related to psychopathy or socialization.

Respiration Responses. For thoracic and abdominal respiration the "guilty" subjects showed relatively more reduction in amplitude to the relevant questions, and the "innocent" subjects showed relatively more reduction in amplitude to control questions. The interaction for respiration cycle time was not significant. Further analyses indicated that responses of "innocent" subjects were in opposite directions to control and relevant questions in measures of thoracic respiration amplitude, $t(44)=2.18$, and respiration cycle time, $t(44)=2.78$. The "innocent" subjects showed a decrease in amplitude and a slowing of rate in response to control questions and an increase in amplitude and a speeding of respiration rate in response to relevant questions. Similar results were obtained with abdominal respiration baseline, and they are shown in Fig. 2. There was a significant "Guilty-Innocent" × Question Type × Cycles interaction ($F(4/128)=3.49$, $MS_e=1.36$). An inspection of Fig. 2 reveals that the "guilty" subjects showed a larger rise in abdominal respiration baseline in response to relevant as compared to control questions, whereas the "innocent" subjects showed greater reaction to the control questions. In addition, the "innocent" subjects showed a drop in baseline in response to relevant questions.

Electrodermal Responses. For SCR, the "guilty" subjects produced relatively larger reactions to relevant questions, and the "innocent" subjects produced relatively larger reactions to the control questions. Overall SCR was greater to relevant than to control questions ($F(1/44)=9.40$). With measures of positive and negative skin potential, the "guilty" subjects showed differentially larger reactions to relevant questions, but the "innocent"

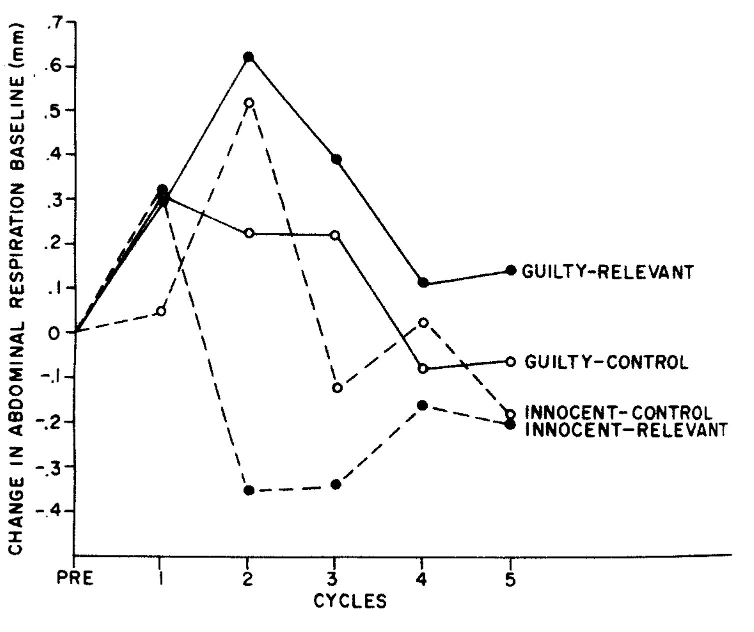

Fig. 2. Changes in abdominal respiration baseline produced by control and relevant questions in "guilty" and "innocent" subjects.

TABLE 3

Mean respiration, electrodermal, and cardiovascular responses to control and relevant questions for "Guilty" and "Innocent" subjects

Groups	Questions	Means							
		Thoracic Respiration Amplitude	Abdominal Respiration Amplitude	Respiration Cycle Time	Skin Conductance	Negative Skin Potential	Positive Skin Potential	Finger Blood Volume	Finger Pulse Amplitude
"Guilty"	Control	− .5	−1.3	0	10.7	.4	.5	5.6	4.9
	Relevant	−1.3	−1.9	−.1	16.7	.6	.8	6.7	6.2
"Innocent"	Control	− .3	−1.2	.2	12.7	.6	.6	6.4	3.8
	Relevant	.6	− .1	−.1	10.2	.6	.7	5.8	3.9
$F(1/44)$		9.77	8.47	2.69	34.52	12.01	7.56	4.15	7.53
Mean Square Error		5.09	6.54	.41	36.23	.07	.13	.13	3.70

subjects did not respond differentially to the two types of questions. However, the psychopaths produced disproportionately larger positive skin potential responses to the relevant questions ($F(1/44) = 5.98$), and both negative and positive SPR was greater to relevant as compared to control questions ($F(1/44) = 8.04$ and 22.44, respectively).

Since hyporesponsivity of psychopaths has often been obtained with SCR, an additional analysis was performed by utilizing extreme subgroups selected by a combination of the ratings of psychopathy and socialization scores. An analysis which included only the low socialization-psychopaths and the high socialization-nonpsychopaths also produced a significant interaction of "Guilty-Innocent" with Question Type ($F(1/20) = 12.49$, $MS_e = 35.16$). A Newman-Keuls test indicated that the low socialization-psychopaths in the guilty condition showed significantly stronger differentiation between control and relevant questions ($M = 7.4$) than did the other three groups ($M < 3.1$). Thus, there was some indication that the most extreme group on the psychopathy dimension showed stronger electrodermal differentiation when they were deceptive to the relevant questions.

Cardiovascular Responses. For finger blood volume and pulse amplitude, the "guilty" subjects showed relatively larger decreases to relevant as compared to control questions. However, the "innocent" subjects produced differentially larger decreases to control questions only in the blood volume measure, and decreases in pulse amplitude were greater to relevant as compared to control questions ($F(1/44) = 9.64$).

Due to equipment problems, HR data were available for only 10 psychopaths and 7 nonpsychopaths in both the "guilty" and "innocent" conditions. The sec-by-sec HR for psychopaths and nonpsychopaths are presented in Fig. 3. The overall form of the HR response consisted of an initial acceleration which reached a peak about the time of the subject's answer, and HR then returned to prestimulus level or below ($F(19/570) = 25.58$, $MS_e = 16.48$). There was a significant "Guilty-Innocent" × Question Type × Seconds interaction ($F(19/570) = 4.27$, $MS_e = 9.84$). The "guilty" and "innocent" subjects showed an initial acceleration following the onset of both types of questions. However, the HR of "innocent" subjects then returned to prestimulus level whereas the "guilty" subjects showed a mean deceleration of 3.7 bpm following the answer to relevant questions. Furthermore, the "guilty" psychopaths showed slightly less acceleration (3.4 bpm) than the "guilty" nonpsychopaths (5.5 bpm) to both types of questions, and they showed stronger deceleration (−4.2 bpm) than the "guilty" nonpsychopaths (−3.2 bpm) to the relevant questions ($F(19/570) = 2.33$).

Discussion

The results of this study clearly demonstrate the effectiveness of the control-question technique in detecting deception employing a mock-crime paradigm with a population of prison inmates. Using the numerical scoring system the accuracy of decisions was 95.5%, and only 8.3% of the tests yielded inconclusive outcomes. Those results provide support for the usefulness of the numerical scoring system developed and employed in field situations.

Since the examiner who numerically scored the charts had direct contact with the subjects and his

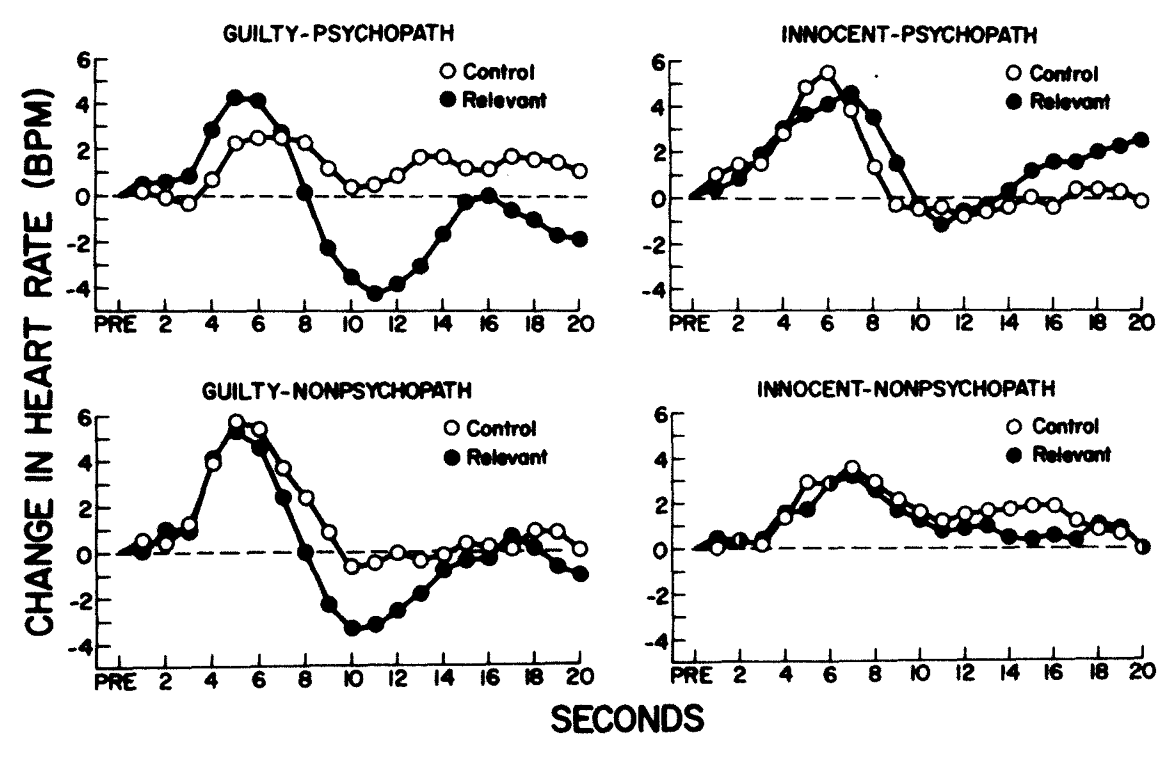

Fig. 3. Heart rate changes produced by control and relevant questions in "guilty" and "innocent" psychopaths and nonpsychopaths.

scoring may have been influenced by the demeanor of the subjects, a question arises about the extent to which the accuracy of the results was based solely on the physiological recordings. Although the present study does not resolve that question, previous research in our laboratory has shown the numerical scoring technique to be highly reliable and minimally affected by contact with the subject (Raskin et al., 1977). That paper includes three studies in which the polygraph charts were numerically scored by one or more examiners who had no contact with the subjects and were blind with regard to their guilt or innocence. Using polygraph examinations from 102 criminal suspects, a correlation of .91 was obtained between the numerical scores assigned by the original examiner and the blind scorer, and there was 100% agreement on decisions. Similar procedures in a laboratory experiment obtained 100% agreement between the decisions of the original examiner and those of the blind scorer. The third study obtained 99% accuracy from seven examiners who employed numerical scoring in the blind interpretation of 16 sets of polygraph charts from confirmed criminal cases. On the basis of those studies it appears that the numerical scoring technique is a highly reliable and accurate method for determining the outcome of the polygraph test and is relatively unaffected by contact with the subject. Of course, adequate training and experience are necessary to employ that technique successfully.

The results provided substantial confirmation of predictions generated from the theory of control-question polygraph tests (Podlesny & Raskin, 1977). Although Lykken (1974) argued that the control question cannot function as proposed, "innocent" subjects showed substantially larger reactions to control questions in a variety of respiration, electrodermal, and cardiovascular measures using field numerical scoring and blind quantitative analyses. On the basis of numerical evaluation, "innocent" subjects produced scores which were as strongly indicative of truthfulness as the scores of "guilty" subjects were indicative of deception. The failure to support Lykken's (1974) analysis is not surprising since he erroneously stated that control questions are designed to be answered truthfully (p. 729) and he erroneously assumed that a lack of difference in responses to control and relevant questions yields a truthful outcome.

The effectiveness of the control question for an innocent subject is crucial to the accuracy of a control-question polygraph test. Since the wording of each control question must be selected by the examiner and individually adjusted according to the subject's answer to the question, the training and skill of the examiner play an important role in determining the accuracy of the outcome. Furthermore, the manner in which the examination is conducted and the way in which the examiner interacts with the subject can also influence the outcome. In the present study, procedures were utilized to enhance the effectiveness of control questions by constantly drawing attention to them between successive polygraph charts. That appears to be an effective method which has been used successfully in a subsequent experiment (Raskin et al., 1977).

The findings of the present study do not support the belief that detection of deception techniques are ineffective with psychopaths. Using a control question test, not a single "guilty" subject was able to produce a truthful result. In a variety of physiological measures psychopaths were as responsive as nonpsychopaths, and they showed evidence of stronger reactivity in measures of HR deceleration, positive skin potential, and skin conductance. The use of the socialization measure to attempt to select a more extreme group of psychopaths did not alter the basic findings and provided additional evidence of stronger differentiation among low socialization subjects.

In some respects, these findings appear to be in conflict with previous research in which psychopathic inmates were found to be electrodermally hyporesponsive to a variety of physical stimuli (Hare, 1978). However, there is evidence that sufficiently aroused or motivated psychopaths are not hyporesponsive. For example, Hare (1968) reported that skin conductance fluctuations of psychopaths engaged in solving arithmetic problems under time pressure were similar to those of nonpsychopaths. Schmauk (1970) found that prison inmates with high MMPI Pd scores and low anxiety scores gave relatively small anticipatory electrodermal responses in an avoidance task involving electric shock or social disapproval, but their electrodermal responses equalled those of the nonpsychopaths when the consequence was loss of money, as in the present experiment.

The results of this study appear to indicate that control question tests may be used effectively with psychopaths in the field situation. Since such tests employ cardiovascular and respiration measures on which psychopaths have not been shown to be hyporesponsive and differential responsivity to control or relevant questions is required to arrive at a decision, the risks in the field situation seem to be minimized by the control question test. However, the present study was conducted in the context of a mock crime, and the extent to which that situation generalizes to the real-life situation is open to some question. If the field situation is motivationally more similar to aversive physical stimulation than to the loss of money utilized in this study, then psychopaths might be electrodermally hyporesponsive and more difficult to detect in deception. If the loss of money is motivationally similar to the potential loss of freedom inherent in the field situation, then there should be no particular problem of generalizability. It is also possible that psychopaths are especially challenged and threatened by the lie detection procedures. Since they have a life style which is characterized by insincerity and manipulation, the prospect of being evaluated on the basis of their involuntary bodily reactions measured by an inanimate instrument may be a unique and threatening experience which produces a high degree of reactivity.

The only data available on the effectiveness of control-question polygraph examinations with psychopathic criminal suspects in the field situation are those reported by Raskin et al. (1977). Their results also seem to indicate that psychopaths pose no special problem for detection with control-question polygraph examinations. However, the limitations of that study prevent it from providing a definitive answer to the question.

The data from the present study provided additional information on the utility of various physiological measures in detection of deception as well as some specific response characteristics associated with truth and deception. Although all measures significantly discriminated between "guilty" and "innocent" subjects, numerical evaluation showed that skin conductance discriminated better than respiration and cardiovascular measures. However, respiration scores provided the strongest indicator for "innocent" subjects. Further analyses of the respiration measures provided evidence that there are changes which go in opposite directions for truth as compared to deception. When "guilty" subjects were deceptive to the relevant questions, they showed decreases in thoracic respiration amplitude and increases in abdominal respiration baseline. However, when "innocent" subjects were truthful to the relevant questions, they showed increases in thoracic respiration amplitude, decreases in abdominal respiration baseline, and speeding of respiration rate. No other physiological measures have shown characteristics which change in opposite directions depending on whether the subject is being deceptive or truthful (Podlesny & Raskin, 1977).

All of the other measures showed reliable effects in the predicted directions. However, the electrodermal measures and finger pulse amplitude showed reliably larger responses to relevant questions. The findings raise some cautions for interpreting those measures since they were more effective with "guilty" than with "innocent" subjects. The two "innocent" subjects whose polygraph charts erroneously indicated deception showed almost all of their inappropriate reactions in the electrodermal and cardiovascular measures, and one of them showed respiration changes associated with truthfulness. It appears that the small risk of errors in control question tests is associated with inappropriate electrodermal and cardiovascular responses to relevant questions in "innocent" subjects, and the presence of respiration responses in the truthful direction should create some suspicion of a possible false positive.

Finally, the finding of a pronounced acceleration of heart rate preceding the answer by "guilty" and "innocent" subjects to both types of questions followed by a strong deceleration to relevant questions in "guilty" subjects raises some interesting questions about the type of responses being manifested. On the basis of Obrist's concept of cardiac-somatic coupling (Obrist, Howard, Lawler, Galosy, Meyers, & Gaebelein, 1974), it seems reasonable to conclude that the initial acceleration is a result of the subject's preparation to answer and his act of answering. However, the subsequent deceleration observed in "guilty" subjects' responses to relevant questions appears to be more of an attentional response which may be associated with an attempt to obtain information from the environment (Lacey & Lacey, 1974; Porges & Raskin, 1969). This latter finding has been replicated in our laboratory (Raskin et al., 1977) and is consistent with that reported by Ellson, Davis, Saltzman, and Burke (Note 2). It may be produced by the subject's attempts to pick up cues regarding the extent to which the examiner has observed a reaction produced by deception to that question. If that deceleration represents an attentional response by the subject, the extent to which the subject is concerned about the responses which his body is displaying may play an important role in producing high rates of accuracy in detecting deception. Leading the subject to believe that any attempt to deceive will be manifested in the polygraph recordings is a typical field procedure (Barland & Raskin, 1973), and the heart rate deceleration observed in this study lends some support to its usefulness.

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