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Improving the Detection of Physical Countermeasures With Chair Sensors

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Abstract

We conducted a reanalysis of unpublished data collected by V. Cholan Kopparumsolan to investigate whether specialized sensors would improve the performance of polygraph examiners in the detection of covert physical countermeasures. Five blind scorers evaluated the physiological data in two conditions. In the first condition they looked at 68 conventional polygraph cases for indications of countermeasures. In the second condition at least two months later they saw the same charts, this time with a channel that displayed data from a sensor designed to detect physical countermeasures. The addition of the countermeasure sensors significantly improved examiners' performance in the detection of physical countermeasures. The presence of the sensor information did not affect the scores or countermeasure ratings of examinees that had not been programmed to perform countermeasures.

keywords: countermeasures, polygraph, sensors

Countermeasures have been a pervasive and persistent challenge in the psychophysiological detection of deception. The idea that a deceptive individual could avoid detection by the polygraph is not new. Even in the earliest exploration of pre-polygraph instruments for detecting deception, examinees were already using strategies in an attempt to defeat them (Benussi, 1914). As the modern polygraph was becoming established in the US during and just after World War II there was no shortage of published advice on how to fool it (Blakemore, 1953; Masserman & Jacques, 1952; Stewart, 1941). In more recent years the advent of the Internet has made countermeasure information easily obtainable.

Though the information proffered on the Internet may be more detailed than in times past, the principal strategy recommended to potential examinees has not changed significantly for more than 50 years: Simply induce reactions on non-relevant questions. The underlying premise is that the manufactured reactions will confound the examiner's ability to interpret reactions on the relevant questions. If the examiner sees reactions to other questions, especially if they are large reactions, he might discount or misinterpret real reactions. Creating reactions is a fairly simple process for most examinees, leading to its popularity as a countermeasure approach.

By necessity polygraph examiners have been forced to pay attention to the effect of Internet advice on their examinees, and as a consequence have come to understand countermeasures better. This has led to methods to detect, deter and defeat them. From an operational perspective, there are four general categories of countermeasures: pharmacological/chemical, behavioral, mental and physical (Krapohl, 1996). Each of these approaches entails particular strategies, but

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all share the common aim of causing a polygraph decision error. The last category, physical countermeasures is the focus of the present paper.

To appreciate how physical countermeasures might be used, it is important to examine how polygraph decisions are made. In modern polygraphy there are three principal types of test questions. First are the relevant questions, which cover the topic(s) that brought the person to the examination. Second, there are irrelevant questions, which are neutral questions added for technical purposes. Last, there are comparison questions. Comparison questions are included as benchmarks, against which reactions to relevant questions are gauged.

In an oversimplification of the actual process, if the greatest reactions are on the relevant questions, the report of the examination is Deception Indicated (DI). Conversely, if the reactions to the comparison questions are the greatest, the results are No Deception Indicated (NDI). Equal reactivity to both categories of questions produces a result of Inconclusive or No Opinion (NO).

Because comparison question techniques (CQT) rely on differential reactions to relevant and comparison questions, any countermeasure that augments the reactions to comparison question or diminishes reactions to relevant questions could be useful to a deceptive examinee attempting to evade detection of his lie. Strategies that increase or decrease reactivity to both types of question simultaneously, such as in the use of drugs or biofeedback, do not lead to a false negative error (calling a deceptive examinee truthful) (Honts, 1987). If an effective method exists for dampening reactions only to relevant questions it has not yet appeared in the literature.

Self-initiating reactions to comparison questions, a second approach, could be effective under the right conditions. Honts and his collaborators (Honts, 1987; Honts, Amato & Gordon, 2001; Honts & Hodes, 1983; Honts, Hodes & Raskin, 1985; Honts, Raskin & Kircher, 1983; Honts, Raskin & Kircher, 1987; Honts, Raskin, Kircher, & Hodes, 1988) have conducted a very thorough investigation into what makes for successful countermeasures. They found that, in order to make physical countermeasures viable, the examinee had to be made aware of the principles underlying the CQT, advised on how to identify comparison questions, instructed in methods for manufacturing reactions, and given feedback from a polygraph examiner or psychophysiologist while being recorded with a polygraph. Their research determined that this last step was essential. Without real-time feedback, countermeasures were not effective for producing a false negative decision. Despite an overabundance of countermeasure instruction guides, the general unavailability of countermeasure training with feedback severely limits the number of successful countermeasure users.

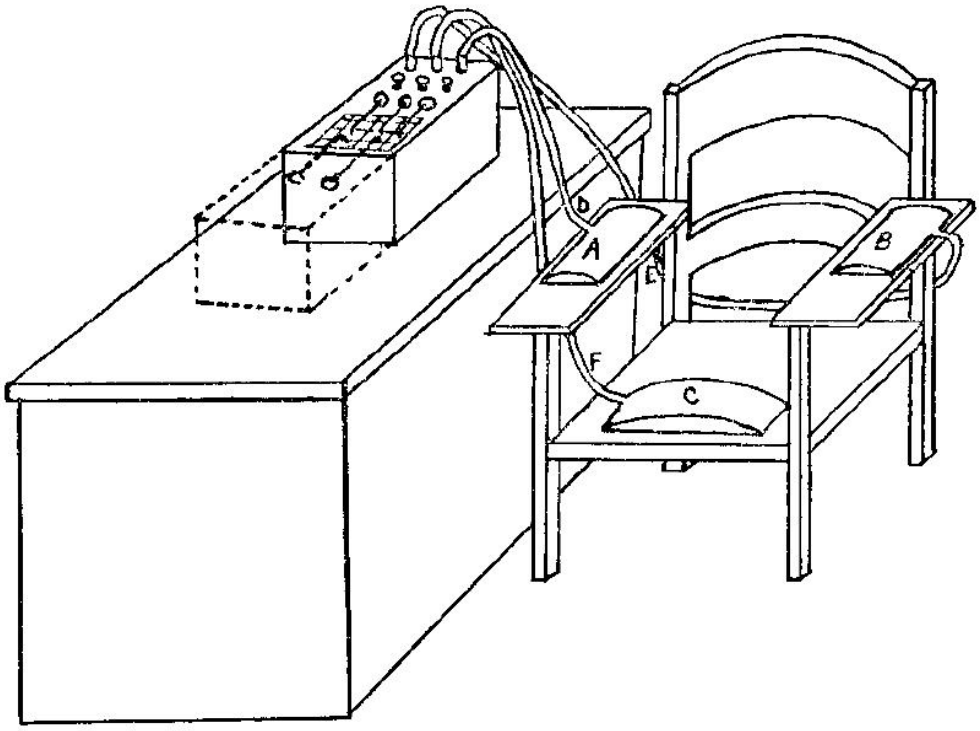
It is interesting to note that recent findings from Honts and Alloway (2007) indicate that the countermeasure instruction proffered on the Internet can affect the polygraph outcomes of truthful examinees who employ them. Their data revealed a clear shift of polygraph scores of truthful examinees toward the deceptive direction when they used countermeasure strategies available on the Internet. Deceptive examinees using the same methods were not successful in moving their polygraph scores in a positive direction. In other words, the Internet advice only hurt truthful examinees. The Honts and Alloway finding regarding the ineffectiveness of countermeasure instruction for deceptive examinees would be predicted from earlier studies, but the negative impact on truthful examinees was unexpected.

Detection of physical countermeasures by polygraph examiners without the aid of special sensors has proven problematic (Honts, 1984; Honts & Hodes, 1983; Honts, Hodes & Raskin, 1985). Examiners do not perform above chance levels when relying on only the conventional polygraph channels to uncover countermeasures. Detection of physical countermeasures is important for a number of reasons. First, they allow for the examiner to gauge the degree of examinee cooperation. Second, detection of countermeasures allows one to determine how much reliance to place on the physiological data. Finally, the ability to detect physical countermeasures provides greater evidence with which to defend the polygraph results.

The inability of examiners to identify physical countermeasures limits confidence that can be placed on truthful polygraph decisions. Any method that improves examiner abilities in this regard would be welcomed.

Reid (1945) published the first design for a device to detect covert physical movements during polygraph testing (Figure 1). Air bladders were placed in the seat and arms of a polygraph test chair, and changes in the bladder's air pressure were communicated to the polygraph and recorded on the strip chart. Reid suggested that detection of movements could be used to gauge the level of the examinee's cooperation. His was not the only technical approach to be suggested in the detection of physical countermeasures. Since Reid's time, methods have included electromyography (Honts et al., 1987) and strain gauges mounted near the rear leg of the test chair (Stephenson & Barry, 1986). Most commercial systems in existence have relied on pneumatic or electric sensors attached to or imbedded in the test chair. All approaches attempt to reveal tactical movements by examinees that might influence the physiological data recorded during polygraph testing.

Figure 1. Design for a system for detecting concealed muscular movements. Letters A and B denote bladders on which examinees place their arms, and C is a bladder positioned below the examinee's thighs. From Reid (1945). Reprinted by special permission of Northwestern University School of Law, *The Journal of Criminal Law and Criminology*.



Evidence for the efficacy of these sensors has been inconsistent (Abrams & Davidson, 1988; Murray, 1989; Ohnishi, Tanaka, & Matsuno, 1968; Stephenson & Barry, 1986; also see Honts, 1987). A general rule, as one might expect, is that the value of the sensor depends on whether the examinee used a physical countermeasure that produces a signal in the sensor. Because examinees may try any number of countermeasure strategies, only a subset of those methods may be detected by the sensors. Even among physical counter-measure strategies, only those executed within the range of the sensor would be detected. A movement sensor-approach to the detection of mental countermeasures, pharmacological countermeasures, or behavioral countermeasures should be ineffective, and other means must be brought to bear against these strategies.

The present research had the limited goal of assessing whether physical countermeasures that are advocated on the Internet can be detected with a commercially available array of sensors. Using a sample collected by Cholan Kopparumsolan in 2002, we evaluated the contribution of the Lafayette activity sensors to the detection of physical countermeasures.

Methodology

Subjects

A total of 96 subjects were recruited from an undergraduate introductory course in criminal justice at Michigan State University in 2002. All had been offered extra credit for volunteering for the study, and told that they could earn a small cash reward at the end of the study. Half of the volunteers were female.

Polygraph Examiner

One polygraph examiner conducted all of the examinations. He received basic and advanced training at an American Polygraph Association (APA) accredited polygraph school, and had more than three years of field experience conducting examinations for both criminal and security applications in Singapore.

Blind Evaluators

Six law enforcement polygraph examiners were recruited to evaluate the polygraph charts. Three were on staff with the Phoenix Police Department, and three were examiners with the Kentucky State Police. One evaluator from the Phoenix Police Department did not complete all of the chart analyses by the close of the study, and his data were excluded from the project. All evaluators received their polygraph training at schools accredited by the APA. The evaluators were not provided any information other than the polygraph charts.

Apparatus

All subjects were seated in a polygraph test chair which was outfitted with motion sensors. The Lafayette 76875S Activity Sensors are designed to detect an examinee's physical movements during testing (see Figure 2.) The seat and arm sensors are urethane air bladders with nylon covers. The sensors for the subject's feet were bladders built into a set of feet plates. Changes in the subject's posture along with increases and decreases in muscle tension cause changes in the air pressure in the affected bladders. The pressure waves are conducted via tubing to a central point where the mechanical energy is converted to electronic signals, which in turn, are represented as a moving line on a computer screen. The line does not identify which of the bladders was affected by the examinee's movement.

A Lafayette LX 3000 computer polygraph (Lafayette Instrument Company, Lafayette, IN) was used to test all of the subjects in this study. During testing the polygraph recorded and displayed breathing patterns from the examinee's thoracic and abdominal areas, electrodermal responses from sensors placed on two fingers of the subject's left hand, and cardiovascular activity using an occlusion cuff placed about the subject's upper left arm. Cuff pressure was maintained between 60 to 70 mm Hg.

Design

The subjects were divided by gender and then randomly assigned to six treatment

Figure 2. Lafayette 76875S Activity Sensors configured with polygraph testing chair. Photo courtesy of the Lafayette Instrument Company, Inc.

groups: innocent, guilty control, guilty practice cognitive, guilty practice physical, guilty experience cognitive, and guilty experience physical countermeasures. Each of the six treatment groups consisted of eight males and eight females. For the present purposes we used only three groups: the innocent, the guilty control, and a single combined group (labeled here as the physical countermeasure group) made up of the guilty practice physical and guilty experience physical groups. The scorers in the present study analyzed all of the cases, but because of the focus on physical countermeasures, only the innocent, guilty control, and physical countermeasure groups are considered here.

Procedure

As stated earlier there were six treatment groups. Only those relevant to the current analysis are reported.

Innocent Group

Subjects assigned to the innocent group did not commit the mock crime, received no countermeasure training or instructions, and were not told to use countermeasures during their polygraph tests.

Guilty Control Group

In this group subjects committed the mock crime, but were not given countermeasure training or instructions nor told to engage in countermeasures during their polygraph tests.

Physical Countermeasure Group

In the physical countermeasure group, the subjects committed the mock crime, received (at a minimum) training in countermeasures as advocated on anti-polygraph.org, and were instructed to try to "beat" their polygraph testing using the strategies offered at the anti-polygraph website.

Instructions to Innocent Subjects

Innocent subjects listened to the following taped instructions:

"You have been randomly assigned to participate in this study as an innocent person. Your task, once this tape is completed, is to leave the building and go for a short walk returning here in approximately 15 minutes. During the time you are out walking, there will be a crime committed, but you will have no knowledge of what transpired."

"Within the next four days, you will be given a lie detection test as a possible suspect in the crime because of you being in the area. You are to speak to no one about your participation in this study and to appear, as you are, innocent. If you pass the test, that is, if the polygraph examination shows that you are innocent, you will earn a small cash reward in addition to your course credit. Good luck, now carry out your instructions."

Instructions to Guilty Subjects

Subjects in the guilty control and the physical countermeasure group were given written instructions on the mock crime they were to commit. The instructions were as follows:

"You have been randomly assigned to be a guilty subject. Your task, if you choose to participate, is to proceed from this location to the elevator lobby in Baker Hall and take the elevator to the fifth floor. Upon your arrival on the fifth floor proceed to room 541, which is the mailroom of the School of Criminal Justice. Once you are there, go inside the mailroom and look for mail slots under the column marked 6 and look for a mail slot marked with an orange tag bearing the name Professor Frank Horvath. Thereafter, carry out a quick systematic search of all the mail in the said mail slot to locate a business size 'airmail' envelope with red and blue markings around the edge and a large 'X' marked across on each side. Once you locate the said envelope, take it out of the mail slot and hide it on your person and quickly leave the mailroom. Should anyone walk into the room while you are carrying out the theft, make whatever excuse you think is necessary and continue on your way. After the commission of the theft, quickly leave the floor and return here by whatever means or route you choose. Remember, you have only 15 minutes to complete this portion of your assignment, so do not waste time. You will be given additional instructions when you return."

"You will be given a polygraph examination (lie detection test) within the next four days. It is very important that you remember that during this examination you are not to tell the person conducting the examination under any circumstance or any reason whatsoever what you have done. Any questions related to the envelope, where it was taken from or contents of the envelope must not be answered truthfully. Deny all involvement with the 'airmail' envelope. If you can successfully accomplish this task, that is, if the polygraph examination shows you to be truthful, you will be rewarded with the contents of the 'airmail' envelope you took."

"Lastly, it is very important that you do not speak with other students about your participation in this study and that you appear truthful at all times. Good luck, now carry out your instructions."

Following the mock crime, guilty subjects received instructions to open the "airmail" envelope where they found two $5 bills. The bills were turned over to one of the trainers. The money would be dispensed to those examinees who obtained a decision of NDI based on the manual scoring of the testing examiner. Subjects were scheduled for a polygraph examination from 1 to 4 days after the programming.

Countermeasure Training

Subjects received a paper copy of the internet publication *The Lie Behind the Lie Detector* (Maschke & Scalabrini, 2002) downloaded from www.anti-polygraph.org website, and studied the instructions for 20 minutes. The publication discusses in detail the polygraph instrumentation, techniques, protocols, and methods of analysis. It also encourages and informs readers how to covertly augment reactions to comparison questions in order to defeat the examination. After the subjects reviewed the material, trainers administered a 10-item written quiz to assess whether the subjects understood the countermeasure instructions. They then provided the correct answers to the quiz items, and answered any of the subjects' questions about the countermeasure

instructions. A subset of the countermeasure group received real time feedback on their countermeasure efforts from an experienced polygraph examiner during a practice test with the polygraph. The polygraph examiner providing the feedback was trained at an APA school, and was a member of the Michigan State Police. The physical countermeasure was consistent with the advice given in *The Lie Behind the Lie Detector*: toe curling during the comparison questions. Subjects were all told to practice their countermeasure methods during their free time before their polygraph examinations.

The Polygraph Examination

V. Cholan Kopparumsolan was the testing polygraph examiner for all examinations. Though he knew the base rates and the types of countermeasure instruction, he was blind to ground truth and countermeasure programming for individual subjects.

The test questions and sequence was as follows.

Q1 Irrelevant - Are you now in Indiana? Answer: No

Q2 Overall Truth - Have you told me the absolute and complete truth about every single thing we discussed here today? Answer: Yes

Q3 Secondary Relevant - Are you now lying to me in any way about the missing airmail envelope from Dr. Horvath's office at 122 Baker Hall? Answer: No

Q4 Irrelevant - Are you now in Michigan? Answer: Yes

Q5 Relevant - Did you remove that airmail envelope from Dr. Horvath's office? Answer: No

Q6 Comparison - Not connected with this case, did you ever take something that did not belong to you, even one time in your entire life? Answer: No

Q7 Irrelevant - Are you now in the United States? Answer: Yes

Q8 Relevant - Did you remove five dollars from an airmail envelope taken from Dr. Horvath's office? Answer: No

Q10 Comparison - Not connected with this case, other than what you told me, have you ever told an important lie, even one time in your entire life? Answer: No

Q13 Irrelevant - Are you now in Canada? Answer No

The first test was a Silent Stimulation Test (SST) in which the subjects were instructed to listen but not answer the test questions (Horvath & Reid, 1972). The SST was followed by a Card Stimulation Test, sometimes called an Acquaintance Test. The third and fourth tests in the series were Verbal Answer Tests. The fifth and last test was the Yes Test, a countermeasure detection method also described in *Truth and Deception* (Reid & Inbau, 1977). In the present analysis only charts 1, 3 and 4 were used. The Yes Test had been excluded because it is designed to prompt countermeasure attempts in a form that are more easily discernable in the charts, and also because in field practice it is not regularly administered. The Card Stimulation Test was similarly excluded because it is a type of approach used by a minority of field examiners, and it too was not relevant to the study.

Blind Analyses

All of the cases were analyzed by the five scorers, but only 68 cases are reported here. This is the number of innocent, deceptive control, and physical countermeasure group, minus four cases which were lost due to file corruption. The 68 cases consisted of 15 innocent, 15 deceptive control, and 38 physical countermeasure cases.

The polygraph charts were printed twice: once with the motion sensor data removed and once with those data present. The scoring of each of these sets of charts was separated by at least two months. The case numbers and order were changed between the first and second evaluation by the examiners. The examiners separately scored the charts using 7-position numerical analysis and they also assessed the likelihood of countermeasures for each case on a five-point

continuum: certainly, probably, unsure, probably not, certainly not. These terms were converted to whole numbers from -2 to +2, respectively. See Appendix A for the score sheet provided to the examiners.

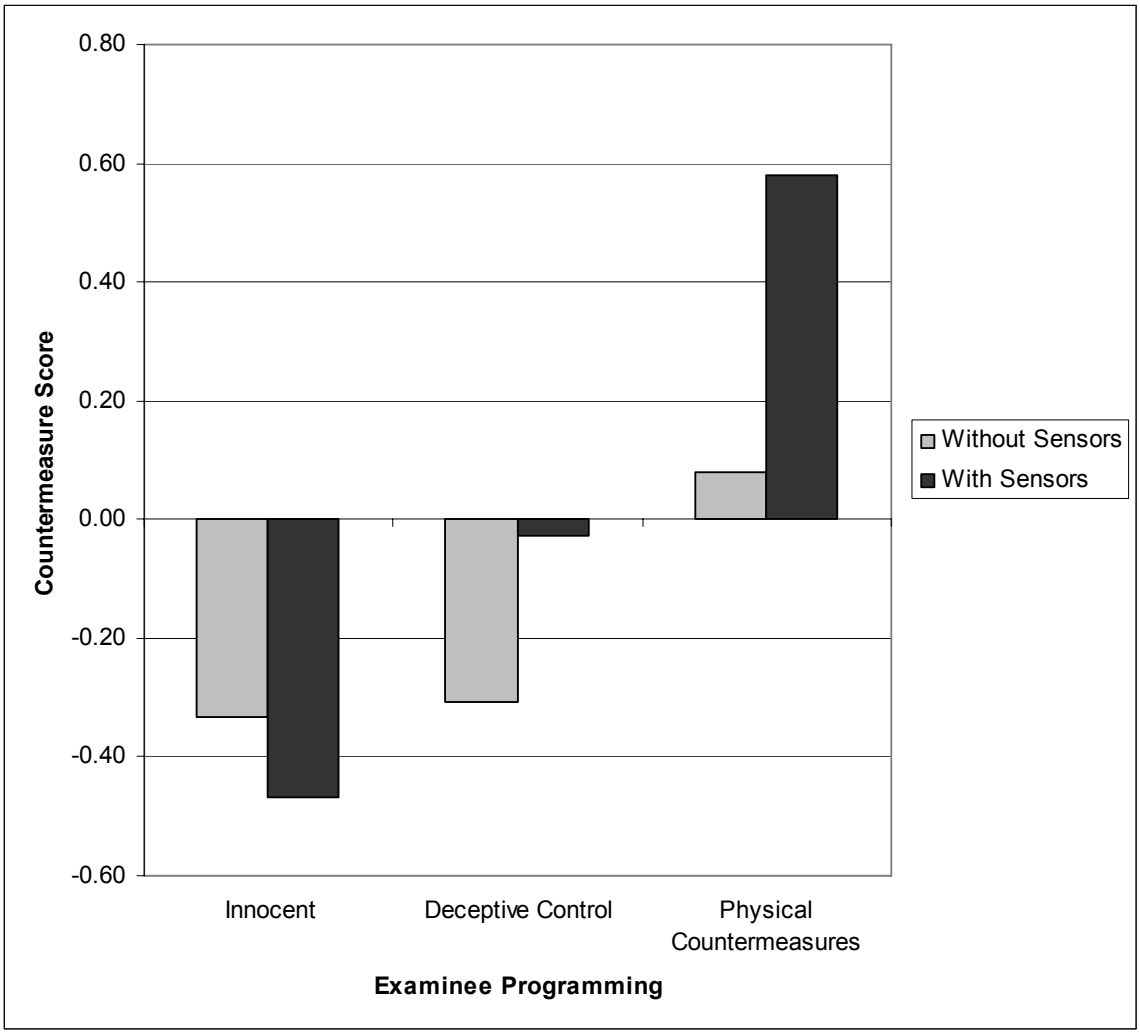
Data reduction

The countermeasure likelihood ratings for each case were averaged across evaluators for each of the three conditions; innocent, deceptive control and physical counter-measure groups. Because of multiple analyses, the Bonferroni correction was used (Miller, 1991). Calculation of alpha of .05 using the Bonferroni correction of α / n was .017 (.05/3 = .017).

Results

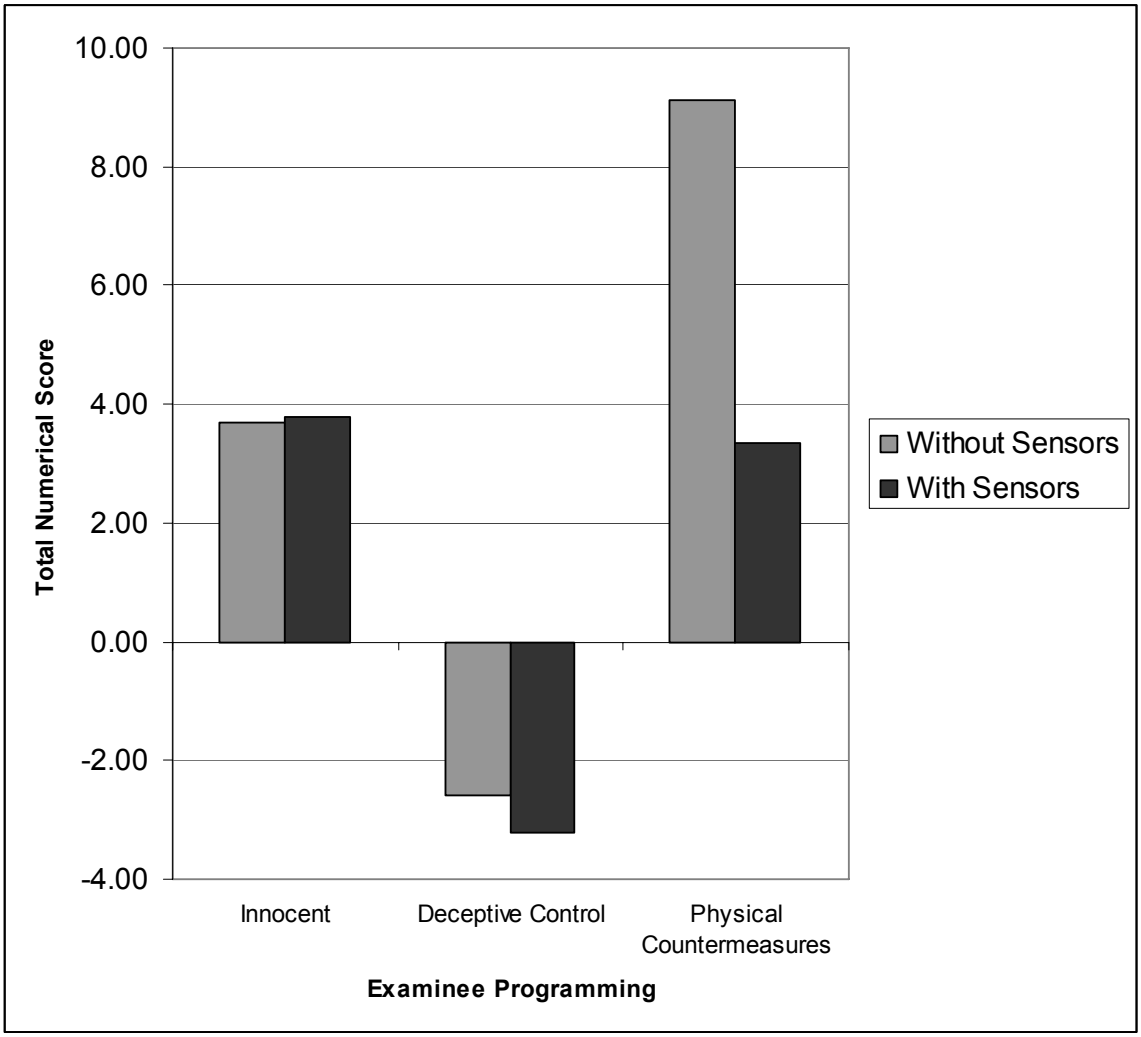
Using a two-tail t test there were no significant differences in the mean counter-measure scores for the innocent cases or deceptive control cases between the sensor and no-sensor conditions (innocent $t[14] = 0.65$, ns; deceptive control $t[14] = 1.20$, ns). Mean countermeasure scores for the physical countermeasure group between the sensor and no-sensor conditions were statistically different ($t[37] = 2.60$, $p < 0.017$). In other words, the addition of the motion sensor data on the charts did not cause the polygraph examiners to increase their estimates of concealed movements in any condition except when examinees were programmed to use physical countermeasures. See Figure 3.

Figure 3. Average countermeasure scores when sensor data are either present or absent.



The effect on numerical scores was similar. The inclusion of the sensor data did not influence the average total numerical scores for innocent subjects (t[14] = 0.05, ns;) nor deceptive control subjects (t[14] = 0.76, ns). However, the addition of the sensor data on the polygraph charts did lower the numerical scores of the deceptive countermeasuring subjects significantly (t[37] = 3.79, p < 0.017). Said differently, the sensor data only affected the numerical scores of deceptive countermeasuring subjects: countermeasuring subjects received significantly lower numerical scores when the sensor data were displayed on the charts. See Figure 4.

Figure 4. Average numerical scores when sensor data are either present or absent.



Discussion

The present analysis points to potential benefits for adding a data channel on field polygraphs. Blind scorers were better able to detect physical countermeasures when the sensor data were viewed along with the traditional polygraph channels than when the sensor data were not displayed. Moreover, the sensor data mitigated the positive numerical scores that had been given to the countermeasure cases in the no-sensor condition though the scorers had been given no instructions in that regard. Moving the numerical scores of deceptive counter-

measurers in the negative direction can reduce false negative and increase true positive results. Finally, the sensor data did not affect either the numerical scores or the countermeasure scores of examinees who were not programmed to use counter-measures. Sensor data affected the countermeasure group only.

Limitations

1. Analog studies can be criticized for lacking the level of motivation and jeopardy that might take place in real world settings. The generalizeability of the present findings has not been established. Our data may over- or under-estimate the ability of polygraph examiners to detect physical countermeasures in the field. Whether high motivation and jeopardy improves or diminishes countermeasure detection is unknown.

2. The countermeasures sensors used here were more extensive than the conventional seat cushion currently found in wide distribution in the field. Whether physical countermeasures of the type used in this study can be detected with the seat cushions alone was not addressed.

Appendix A. Examiner Score Sheet

File # _____ Scorer_____ Date_____

Chart 1

Question #	3	5	8			
Pneumograph						
Electrodermal						
Cardiograph						
	_____	_____	_____			

Chart 2

Question #	3	5	8			
Pneumograph						
Electrodermal						
Cardiograph						
	_____	_____	_____			

Chart 3

Question #	3	5	8			
Pneumograph						
Electrodermal						
Cardiograph						
	_____	_____	_____			

Totals→ _____ _____ _____

Decision _____DI _____NDI _____Inc

Countermeasures

Check one →

_____	_____	_____	_____	_____
Certainly	Probably	Unsure	Probably not	Certainly not

Comments

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