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A CARDIO ACTIVITY MONITOR

By Ronald E. Decker, Allan E. Stein and Norman Ansley

The Need for the CAM

The Cardio Activity Monitor, or CAM, was developed as a substitute for the conventional sphygmograph channel in polygraph instruments. It belongs to that general family of instruments called plethysmographs. Testing on the CAM is not yet complete, but enough work has been done that a report is worthwhile. Moreover, the Steelting Company is in the process of preparing a similar instrument for the market. Please note that their commercial instrument is not exactly like the CAM described in this report. The theory is the same but the amplifier and sensor are different.

To be a substitute channel, the CAM should be capable of continuous operation for up to one hour with no discomfort or physical damage. The relative comfort of the CAM will permit tests that are longer than possible with the conventional blood pressure cuff and will avoid all the discomfort experienced with the present equipment.

Several experimental CAM instruments have been built. This report will provide a brief background of their development, and the results obtained from the most recent model. One of the problems in producing an acceptable CAM was to get it to produce a wave form so similar to that of the current channel that no retraining of examiners would be necessary. In fact, if possible, the wave form should be exactly like that of the sphygmograph, and the patterns should track each other perfectly.

Although not stated as a precise requirement, it was expected that the final model must be small enough to be incorporated as a channel in a polygraph instrument and be capable of production at a reasonable cost. Any instrument that was too large or too expensive would have little immediate benefit to the field. Last, the CAM should be stable, reliable, and serviceable.

Two Different Approaches

Under research contracts by the U. S. Air Force, commencing in 1967, two types of instruments were developed. One instrument was designed and built by Southwest Research Institute of San Antonio Texas. It operated on the principle of determining
blood flow, or velocity, by a measure of the ultrasonic doppler shift of flowing blood in an artery. The other instrument, developed by Biometrics, Inc., of Waltham, Massachusetts, was based on the principle of tonometry and used a small water-filled pressure sensing chamber to monitor the radial artery.

A Doppler System

The instrument produced by Southwest Research Institute radiated a harmless acoustical beam up or down the stream of a peripheral artery and received part of that acoustical energy reflected back from the flowing elements in the blood stream. According to the Doppler effect, the reflected ultrasonic signal is shifted in frequency by an amount proportional to the velocity of the flowing blood elements. The circuitry shaped the Doppler signal to resemble the conventional cardio wave form, and it was put on a standard chart. The equipment combined the Doppler system and a standard sphygmograph channel (Heath and Ware, 1970).

Although the Doppler system measured the arterial flow as desired, the output signal was contaminated by a venous flow signal that could not be removed. Also, there was electrical noise in the pattern. Field tests clearly indicated that the Doppler patterns were not the same as those produced by the conventional cardio channel (Miller, 1969). Accordingly, a decision was made to abandon the Doppler technique.

A Tonometry System

The first instrument produced by Biometrics, Inc., consisted of four sections: a sensor assembly, an amplifier, a pressure controlling module, and a kymograph.

The sensor assembly is a water-filled chamber with a very thin rubber diaphragm which is placed over the radial artery at the wrist. The diaphragm is hydraulically inflated, partially compressing the artery. This partial occlusion is similar in principle to the conventional cuff. The pulsations of the artery are transmitted through the wall of the diaphragm into the hydraulic chamber of the sensing module where they are detected by a pressure transducer (Brubaker, Worthen, Feather and Newman, 1969). The diaphragm area of the sensor assembly is small so that it will compress only tissue immediately overlying the radial artery. Thus, venous flow is relatively unobstructed.

Two models of the current CAM are in use. The U. S. Air Force is using a CAM as an extra channel in regular cases
to study its usefulness. This report is based upon polygraph examinations conducted by the Polygraph Committee of the U. S. Army Military Police School which is conducting carefully controlled laboratory polygraph tests employing mock crimes. The mock crime paradigm has been used for 20 years at the Army polygraph school, and has proved successful in producing reactions like those encountered in field operations. Programmed crimes involve suspects who have committed the offense, or have knowledge of the offense, or have no knowledge or connection with the offense. The suspects and examiners have not met before the test.

Tests with the CAM involved all the standard techniques such as the peak of tension, modified general question, relevant-irrelevant, zone of comparison, etc. All the other channels in the polygraph instrument were also in use. The channels were the cardiosphygmograph, galvanograph, and two pneumograph sections.

Not enough cases have been conducted to prepare a meaningful statistical report. To date, only 27 complete cases have been conducted under rigid controls. Examples from charts made during these tests are included in this report.

Biometrics CAM

The instrument during these tests is the CAM manufactured by Biometrics, Inc., 40 Ames Street, Cambridge, Mass. 02142. This unit combines a CAM channel and a standard polygraph. A Stoelting Emotional Stress Monitor polygraph has been modified by Biometrics to include a CAM as one of the channels.

The Biometrics CAM is made up of three basic subassemblies (fig. 1) housed within the standard Stoelting polygraph. They are:

1. The Sensor Assembly comprised of the diaphragm chamber, diaphragm, pressure transducer and wrist strap.

2. The Pressure Control Assembly which is made up of the water and air reservoirs, the gauge, bulb, and valve.

3. The Amplifier module and its associated power supply.

The modified polygraph is suitable for use on either 115v 60 cycle or 220w 50 cycle A.C. power. Biometrics has incorporated into the instrument a simple method of power changeover. The CAM unit has been placed in the Stoelting (22600 series) between the lower pneumo and the GSR sections.
Radial Artery Selected

The Sensor Assembly is designed specifically to detect the radial pulse. This location was selected because the radial artery is easy to locate and accessible without removal of clothing. It was technically a good selection because the radial pulse can be partially occluded for long periods of time without discomfort. This is because the ulnar artery distributes blood to the same general area through parallel channels.

Biometrics Pressure Controlling System

The Pressure Controlling System consists of an inflation bulb and valve, an air reservoir, a water reservoir, and a pressure gauge. The system controls the force exerted by the diaphragm of the Sensor Assembly thereby controlling the degree of compression of the radial artery.

Upon inflation of the air reservoir and closure of its valve, the pressure in the air reservoir and the water reservoir are equal as indicated by the pressure gauge. The water reservoir is connected to the chamber of the Sensor Assembly through a narrow capillary tube which throttles the rate at which equalization of pressure between the Sensor chamber and Pressure Module takes place. Thus, the water in the Sensor chamber pulsates with the arterial pulse and reflects the transient changes in blood pressure. The Pressure Controlling System is ordinarily inflated to that pressure which gives the maximum pen swing, but never over 60 mm. Pressure in excess of 60 mm may damage the transducer and is not necessary.

Amplifier

The Amplifier section produces excitation for the pressure transducer strain gauge bridge, which takes the bridge output, rectifies the signal, and converts it into the driving current for the recorder pen motor. The gain of the driver stage is variable, thereby providing a sensitivity adjustment for the chart trace. The DC bias on the driver stage is also adjustable, giving a variable centering control on the chart (fig. 2).

Placement of the Sensor

The Sensor diaphragm is usually placed about two fingers' breadth away from the skin crease at the wrist and one finger's breadth from the thumb side of the forearm where it lies between the radius bone on the outside and the flexor tendons in the middle of the forearm. Either wrist may be used (fig. 3). When both the CAM and cardiosphygmograph are in simultaneous use, they must not be on the same arm. When a blood pressure cuff is inflated on the same arm as the CAM, it reduces the CAM pattern to a point where it is useless.
The Sensor is held in place by a strap with Velcro material. The palm must be up, and the hand immobile during testing. If the attachment has been properly placed, the examiner will obtain a tracing of pulse amplitude of about 3/4 inch (17mm). However, exact amplitude may be adjusted with the sensitivity control.

Placement of a Problem

Examiners have found that the most difficult aspect of operating the CAM has been the placement of the Sensor diaphragm. In a few cases, inexperienced examiners were unable to place the attachment in the exact position necessary to obtain an adequate tracing. In other cases, there were large motion artifacts in the pattern because the diaphragm was near, but not exactly over the artery. Other failures were the result of the strap being too loose, the pressure too low or too high, too little water in the reservoir, or the Subject moved.

Capillary Recordings with the CAM

Since the CAM is a volumetric plethysmograph, an attempt was made to employ it on the ulnar artery and the thumb. Placement over the ulnar artery did not produce satisfactory patterns. Placement of the sensor on the thumb produced excellent patterns with respect to pulse volume and rate. The pattern width was about an inch, and at times, the dicrotic notch appeared.

The same elastic band was used to place the sensor over the thumb. If regular tests are to be made from the thumb, a better means of attaching the sensor should be devised. The best recording was obtained by placing the hand on its side, thumb up. When a record was made with the palm side down, the pattern was small and unstable.

When the CAM is used at the thumb, it is recording capillary volume changes, from an arbitrary mean. Quantitative measurement is not possible. Although there may be some relationship between arterial pressure and capillary volume, experiments by Burch and DePasquale (1959) indicate that capillary volume at the end of the finger changes in a manner quite independent of arterial pressure. Therefore, an examiner using a CAM at the digital extremity should not expect it to be a substitute for his sphygmograph recording, or a CAM recording taken at the radial artery.

Charts were made for the purpose of comparing the CAM with the photoelectric plethysmograph. The Stoelting plethysmograph
cell was placed over the little finger of the right hand, and the CAM sensor was placed over the thumb of the right hand. Because the Stoelting pattern is inverted, the tracings moved in opposite directions. A rise in the CAM pattern was countered by a lowering of the plethysmograph pattern. Pulse amplitude and frequency was excellent in both. Since neither recording is quantitative, their relative sensitivity could only be matched by setting the instruments to produce patterns of about the same size in pulse volume.

The deep breath is known to produce sudden and severe pen deflections when recorded by the photoelectric plethysmograph. The same pattern was recorded by the CAM. When parallel patterns were run, the two instruments produced almost identical reactions to the deep breath. This suggests that the effect of oxygen in the blood, which changes the color of the blood, is not a very important factor in recording by Stoelting photoelectric plethysmograph. It does indicate that the capillaries constrict following a deep breath. More studies should be made to determine the relationship between breathing and the capillary volume. (FIG. 6)

Whether or not the CAM is a useful polygraph channel when used to record capillary volume changes at the thumb is a matter for further investigation.

Test Standard Needed

The manufacturer did not produce any test equipment to use with the CAM. Because the CAM does not produce a quantitative measure other than pulse frequency, there is no external measure to establish if it is providing an accurate picture of the pulse volume and pressure wave. The pulse frequency can be easily measured by other means and checked against the CAM recording. Otherwise, the only check available is a comparison of the cardiodynamics tracing and the CAM tracing, a rather subjective proceeding.

It would seem that test equipment should be built that will produce a measurable and precise input which can be used to calibrate the CAM against a performance standard. The test equipment should be used at regular intervals and after the instrument has been adjusted or repaired. If possible, it should be built into the instrument and easy to use.

Impressions of the Examiners

Although not enough tests have been done for a final analysis, some immediate observations and impressions may be
of interest. The location of the CAM sensor is critical. If the correct location is obtained on the first attempt, about five minutes is taken while feeling the pulse, bleeding the CAM liquid system of air bubbles, attaching the sensor, and establishing the pattern. More time is needed if the sensor is not correctly placed during the first try. There have been cases where inexperienced examiners have not been able to get any recording because they did not place the sensor correctly. Experienced examiners have obtained tracings from all subjects, but not always on the first attempt.

It may be possible for an experienced examiner to learn to use the CAM from a carefully prepared manual. Training of examiners in a personal situation takes about 1 1/2 hours, and then quite a bit more time is needed for practice in learning to place the sensor. It may be that an ancillary device could be developed that would assist in locating the correct position, possibly employing the same amplifier that is used with the CAM.

The position of the hand, with the palm up, is not comfortable. The CAM tests were conducted with chairs that were specially designed for polygraph testing. The palm up position may be comfortable on the leather chairs or recliners used by some examiners. It may be desirable to develop a pad or two that will make the position more comfortable and reduce movement. When the hand is placed on its side, little finger down, the comfort is satisfactory but there is too much movement.

None of the persons tested with the CAM have complained of discomfort. Examiners who have worked with it believe that it could be used for long periods without discomfort. The initial criterion of one hour without discomfort has certainly been achieved. This is not to say there is no back pressure; there is. However, there is no discomfort. Many patterns can be run with no pressure added to the system. The pressure of the retaining strap is often sufficient. Some pressure, up to 50 mm, helps achieve additional amplitude and more stability.

To determine the effect of the CAM pressure on the photoelectric plethysmograph, tests were conducted in which the photocell was placed on the extreme end of the little finger, and the CAM was activated with pressure increases at 10 mm increments. About 30 seconds was allowed between changes to permit adaptation. There was no change in the plethysmograph amplitude while CAM patterns were obtained at zero, 10, 20, and 30 mm of pressure. At 40 mm of pressure, the pulse amplitude of the plethysmograph diminished from slightly over one inch to
one-half to three-quarters of an inch. Thereafter, the pulse amplitude of the plethysmograph remained the same up to 60 mm to CAM pressure. The latter is the maximum permissible operating pressure. Except for the pulse amplitude, there was no detectable variation in the plethysmograph pattern which could be attributed to the CAM pressure.

Reactions recorded by the CAM and cardiosphygmograph have been compared (figs. 4, 5, 6). Changes in pulse frequency match perfectly. However, the patterns were not perfectly consistent when compared for changes in pulse amplitude, vasoconstriction, or mean blood pressure. Generally, the same information is found in both patterns. However, there were a number of cases where there were reactions in the cardiosphygmograph tracing which did not appear in the CAM. There were some cases where the CAM had a better reaction pattern and one instance of rise in mean pressure recorded by the CAM which did not appear in the cardio tracing (figs. 7 & 8). Although it is true that there is a reduction in the amplitude of reactions recorded by a conventional cuff at the wrist, when compared to reactions recorded at the upper arm, it is doubtful that this accounts for the apparent insensitivity of the CAM. Those blood pressure reactions recorded from the brachial artery which did not show up on the cardiosphygmograph pattern obtained from a cuff over the radial-ulnar arteries were quite small (Ansley, 1959). The CAM has failed to record some cardio patterns of normal size. Another anomaly is the occasional divergence of blood pressure patterns. There are a few charts on which there is a rise of mean blood pressure in the cardio tracing and a corresponding fall in the CAM tracing. Whether this is a failure in instrumentation or an accurate recording of what is occurring at separate locations is unknown. From a practical viewpoint, it presents an immediate problem in applying the current criteria for chart interpretation. Another problem inherent in comparison is the assumption that the cardiosphygmograph pattern is a perfect standard; it is not.

Although considerably more testing will be conducted before a final report will be made, preliminary results suggest that the CAM is not yet ready to replace the cardiosphygmograph.

As for a current value in the field, it has been suggested that it might be used to develop polygraph techniques which do not have the current short-time limitation and the companion requirement for multiple charts. This research should begin now, anticipating improvement of the CAM or development of a similar instrument. Also, those few examiners that now conduct long examinations with only the pneumograph and galvanograph,
then select the sensitive questions for specific testing, might benefit now by using the CAM in the early testing phase (fig. 9).

From the positive viewpoint, the CAM is closer to being a substitute for the sphygmograph than any other instrument we have seen. Hopefully, the changes needed to bring its performance up to that of the sphygmograph are only minor alterations in components or instrument design.

**BIBLIOGRAPHY**


**Note**

Biometrics, Inc., has reportedly been purchased by the parent company of Narco Bio-Systems which now produces research
polygraph instruments. They may enter the law enforcement and security field with a commercial polygraph employing the Biometric CAM. Stoelting Company is also developing a CAM channel to be incorporated in its Multigraph Series.

![Diagram of a polygraph instrument]
FIGURE 4
COMPARISON CARDIOACTIVITY MONITOR
& STANDARD POLYGRAPH.
CAM used on the pad of the right thumb as a pressure p
plethysmograph. CAM pressure of 40 mm.Hg. Note effect of deep
breath constricting capillaries. Reaction patterns are similar.

**Fig. 6**

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THE DILEMMA OF THE ADMISSIBILITY OF POLYGRAPH EVIDENCE

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In the past generation, technological advancements have been made that stagger the imagination of mankind. Law enforcement, like almost every other facet of our environment, has felt the impact of these advancements on its day-to-day activities. In spite of miserly appropriations on the one hand and a reluctance to depart from traditional methods on the other, the police have made use of modern technology to modernize their tactics in the war against crime. This has done much to improve the public image of the policeman and to stimulate the demand for professional standards by progressive police administrators.

As with other electronic devices used by the police, the polygraph has become much more sophisticated than it was prior to World War II although the basic principles have remained fundamentally unchanged. Since the late 1930's, law enforcement has made extensive use of this instrument, and it represents a valuable investigative technique to police departments who utilize it properly and employ highly trained specialists to conduct the examinations.

Although the use of scientific evidence was well established in the American courtroom prior to the Second World War, it has become increasingly utilized since that time. This is not surprising in view of our increased reliance upon science and technology to solve our everyday problems. As a result, the opinions of expert witnesses carry great weight in modern jurisprudence. This is especially true in the forensic sciences where statements of laboratory specialists in regard to firearms identification, fingerprint comparison, the analysis of body fluids, and the area of questioned documents are accepted by juries who must ultimately decide the guilt or innocence of an accused in criminal trials. Without doubt, scientific achievements in this area have done much to assist in the equitable administration of criminal justice.

In the realm of scientific evidence, however, the polygraph examiner is conspicuous by his absence from American courtrooms. Although the results of polygraph examinations are extremely valuable to the police in gaining confessions and developing other investigative leads, mention of the test results is taboo in the courtroom and has frequently been considered a reversible error by appellate courts throughout the nation.
As early as 1927, legal experts were advocating the use of polygraph test results as evidence in the courtroom. In that year, Charles T. McCormick stated that, "If science bids fair to furnish a fairly effective technique for the exposure of deception, we should not merely welcome it when it comes but stimulate and encourage efforts to speed its coming." Twenty-six years later, William Wicker wrote in the Tennessee Law Review, "As polygraphic interrogation is now the best available method of detecting deception, the time has come for the courts to reappraise this type of evidence and perhaps to admit it on the issue of credibility to be given to the testimony of key witnesses."²

Little progress was made during the interim between these two statements in respect to gaining high court acceptance of polygraph examinations as evidence in court cases. Since courts are still hedging on this matter, an understanding of the dilemma is necessary if the polygraph is to be viewed in its proper perspective within the framework of criminal justice.

A key phrase in describing the major issue involved is that contained in Professor McCormick's statement where he refers to a "fairly effective" method of determining deception on the part of both suspects and witnesses in criminal cases. As mentioned in the preceding chapter, courts have traditionally rejected the evidential value of polygraph examinations on the basis that they have not gained general scientific acceptance and are not infallible. This question of fallibility is the central theme in the controversy and is probably the main reason courts have rejected its use as evidence.

Legal scholars, such as McCormick, Inbau, Wicker, and Kaplan, have consistently opposed the view that the polygraph must be infallible before it is admitted as evidence in criminal cases. In a penetrating discussion of this matter appearing in the Wayne Law Review, Adria G. Kaplan rejected this requirement. Furthermore, he charged that the courts have not only excluded polygraph evidence, but they have judged it by different standards than those which they utilize to determine the admissibility of other scientific evidence.³

To understand this charge of double standards, a basic understanding of the law of evidence is helpful. Generally speaking, all evidence, whether scientific in nature or not, must be relevant and material to the case at hand. To be relevant, evidence must logically influence the issue in question. To be material, however, it must have substantial importance beyond the mere fact that it is relevant. Concisely stated, all evidence must have probative value aside from its competency and must further, to some extent, aid efforts made by the court to solve the problem put before it.⁴
In addition to this, certain policy factors must be considered, one of the most important of which is the possibility of misleading the jury. This eventuality must be avoided insofar as possible. Also important is the fact that no evidence should be introduced that would injure one's position in the eyes of the court. The final decision in evidential matters rests with the presiding judge who, after duly considering all aspects of the problem, must rule as to whether or not the evidence presented will be admitted.

The same rules apply to scientific evidence that is made available to the court by expert witnesses. Even the comments of expert criminalists must be reviewed by the court to determine if they have probative value. In this regard, such witnesses must have personal knowledge of the facts they discuss. Such facts may be derived from scientific instruments, provided the witness can testify as to the accuracy of such instruments as well as to the reliability of the procedures used. Both the instruments used and the processes involved must have a certain degree of general recognition.

According to Kaplan, the courts have not applied these standards to evidence gained from polygraph examinations. Instead, they have consistently excluded all such evidence on the basis that it has not received general scientific acceptance and that a possibility of error exists in its findings. He points out that other scientific evidence does not have to meet a standard of infallibility prior to being introduced as evidence at a criminal trial. Ballistics, blood grouping in paternity cases as well as to identify, and chemical tests for intoxication, all fall into this category.

General scientific recognition is a perplexing problem for exponents of the polygraph. While Kaplan contends that only a certain degree of recognition is required, most polygraph examiners agree that general scientific recognition would be desirable in order to establish the credibility of polygraph techniques before the bar of justice.

One of the concerted efforts to evaluate the degree of scientific acceptance accorded the polygraph was made by the University of Tennessee in the early 1950's. In this research project, efforts were made to include all groups and individuals who were known to have competence in the area of polygraph examination. The persons and groups contacted included: 1) all persons listed in the 1950 Directory of the American Psychological Association as Fellows of the Divisions of General Psychology, Experimental Psychology, Personality and Social Psychology, and Clinical and Abnormal Psychology; 2) all members of the American Society for the Advancement of Criminology; 3) all members of the International
Society for the Detection of Deception; 4) all manufacturers of polygraphic equipment; and 5) all known polygraph examiners.6

Of the 1,682 questionnaires mailed out, 719 of the respondents answered with usable data, which amounted to an average of 43 per cent. An additional 115 replied that they were not qualified to comment. This made the total reply only approximately 50 per cent. In February, 1953, Edward E. Cureton published the results of the survey in the Tennessee Law Review, and though rather inconclusive, they are worthy of note.

Of the 199 examiners who answered, 83 per cent believed the polygraph to be highly valid for measuring physiological reactions. Forty per cent recommended court testimony by competent operators. Out of the 230 psychologists who had conducted polygraph tests either of an experimental nature or actually under field conditions, 63 per cent considered the polygraph valid for measuring physiological reactions, but only 63 per cent recommended court testimony. It is significant to note that no appreciable portion of any group surveyed considered the polygraph useless in competent hands.7

Mr. Cureton recognized that the results of this survey were rather inconclusive as to whether or not the polygraph has gained general scientific acceptance. He cited two reasons for the inconclusive nature of the findings. First, the respondents were not asked directly whether they felt that the polygraph was highly accurate in detecting deception in the hands of a qualified examiner. Second, there was some controversy among the respondents as to the status of the terms emotional and emotional reaction.8

In the final analysis, Mr. Cureton concluded that the psychologists who should be able to grant the polygraph general scientific acceptance may be unable to do so. He attributed this to the fact that they have confined their studies mostly to controlled experiments and are not familiar with the results gained from field service use of the instrument. In spite of his pessimism, the results of the University of Tennessee research project are far from damaging to the cause of those who seek court recognition of the instrument's evidential value. Although general scientific recognition was not accorded to the polygraph, certainly adequate recognition of its value in measuring physiological response was gained to suit the purposes of those who agree with Mr. Kaplan that all that is required is a certain degree of acceptance.9

Those who oppose the use of polygraph examination reports in the courtroom do so mainly on the question of its accuracy. They contend that such tests are often inaccurate and therefore inconclusive. Aside from certain psychological considerations, they blame this inaccuracy on the failure of examiners to use uniform procedures in the conduct of polygraph tests.
John E. Reid of Chicago, Illinois, is probably the most distinguished polygraph examiner in the United States. He claims that in the hands of a skillful examiner the polygraph is 95 per cent accurate as to determining the guilt or innocence of a subject. Only five per cent of those examined will be inconclusive, due to psychological and physiological reasons, while the margin of error will be no more than one per cent.

Between 1938-1941, a total of 1,127 suspects were examined on the polygraph by the Chicago Police Department. Forty per cent of those examined appeared to be innocent, while another 40 per cent appeared to be guilty. The remaining 20 per cent of those examined had inconclusive test results. An interesting sidelight is the fact that 85 per cent of those who appeared to be guilty during their examinations subsequently confessed to the crime in question. During this period, a two per cent margin of error was discovered. Ten years later in 1951, the police department of Seattle, Washington, tested 175 suspects in which there was a margin of error of 2.3 per cent. Five per cent of those examined had inconclusive results; 53.1 per cent appeared to be innocent, while 41.1 per cent appeared to be guilty. No record of subsequent confessions was available.

Although these tests indicated a rather slight margin of error, most experts in the field agree this does not represent a true cross-section of test results. A margin of error as high as 30 per cent could be expected in some examinations where the accuracy of the instrument and the competency of the examiner are questionable. In such cases, the physiological and psychological condition of the subjects examined may also add to the distortion, which makes such test results most undesirable.

Fred E. Inbau discussed this problem in an article that appeared in the Journal of Criminal Law. In his presentation, he attributed most polygraph errors an inconclusive test to either unfit subjects or unfit examiners. Frequently, subjects are unfit for examination for two reasons: 1) because of the treatment they have received from police investigators before taking a polygraph test, and 2) because of physical abuse during the arrest and subsequent accusations of guilt make conclusive findings impossible. Due to the absence of these considerations, Mr. Inbau indicates that polygraph examinations are far more accurate in personnel examinations than in criminal cases. He goes on to offer some sound advice for police polygraph examiners who desire to increase the accuracy of their examinations. According to this noted expert, they should: 1) refuse to test a subject who has been physically abused, 2) or subjected to intensive interrogation, and demand that 3) polygraph examinations be conducted early in a criminal investigation rather than be used as a last resort technique to obtain a confession.
In an article entitled "Scientific Evaluation of the 'Lie Detector'," Eugene E. Levitt pointed out other causes of error that make the polygraph unacceptable for general courtroom use. High on his list of causes of error were bias on the part of the examiner and misleading cues given by him that could cause an innocent person to respond in a guilty manner. According to him, even a sudden change in voice by the examiner could provide such a cue. Also, psychopathological and physiopathological considerations could cause distortion and render examinations either inaccurate or inconclusive. A constant problem that must be dealt with is acute tension in an innocent suspect. This tension is caused by a number of things, the most common being anxiety from being under suspicion, fear of an inaccurate reading, resentment at being subjected to an examination, or guilt feelings that arise from a different offense.\(^\text{14}\) All things considered, Mr. Levitt feels that the multiplicity of these deception criteria make consistently accurate interpretation of responses almost impossible. Therefore he concludes, the extensive use of polygraph test results in the courtroom is inadvisable.

Some opponents of the polygraph feel that it should never be used as evidence in criminal cases regardless of the degree of accuracy attained. According to Joseph H. Koffler, "...progressive reduction of the area of error in the polygraph technique will correspondingly increase the probability of grave injustice to the individuals who fall within this area." He fears that individuals will be convicted on the basis of little more than fragmentary evidence and the erroneous adverse reading of a polygraph test. Furthermore, certain individuals would be more prone than others to this kind of jeopardy because in their cases, due to their physical and emotional characteristics, an erroneous adverse reading of a polygraph examination is more likely to occur. His most valid contention, however, lies in the possibility that as the margin or error is reduced, less collateral evidence will be required in order to convict. Therefore, it will become progressively more likely that the person with an erroneous adverse reading would be convicted.\(^\text{15}\)

Koffler is also concerned about the likelihood that a person could be convicted on the basis of polygraph evidence, even though the other evidence presented by the prosecution was extremely weak. He contends that even detailed instructions to the jury as to the probable weight to assess such testimony would not preclude this possibility. In this eventuality, the use of polygraph evidence would, in effect, destroy reasonable doubt in the minds of the jury.

The exponents of the polygraph reject Koffler's concern over the possibility that once the results of an adverse examination are into evidence that it would automatically be the death blow.
for an accused despite weak collateral evidence of his guilt. They contend that the purpose of admitting test results is to show the state of knowledge of the accused concerning the incident in question. In this regard, Charles T. McCormick contends that polygraph tests results would be admitted only as circumstantial evidence of truthful intent or its reverse. If polygraph test results can make the credibility of witnesses more certain, he feels that courts should admit the evidence even though the possibility of error in the inference is recognized.\textsuperscript{16} The theory in this instance is that conclusiveness in the inference called for is not a requirement for admissibility.

In an outspoken article entitled, "The Lie Detector--A Critical Appraisal of the Technique as a Potential Undermining Factor in the Judicial Process," Joseph H. Koffler denies that the testimony of polygraph examiners is no more than circumstantial evidence. He states that circumstantial evidence is weighed according to how closely it associates the accused with the crime in question. By use of polygraph evidence, he argues, an accused is subjected to a great deal of suspicion and accusation not "because he, as an individual, is identified with a particular fact which in turn associates him with the crime, but merely because his body does not react in accordance with the norm, or the test readings are erroneous for some other reason.

Koffler continues his discussion by stating that ballistic and fingerprint evidence tend only to prove a particular fact as a piece of circumstantial evidence. Also important, he adds, is the fact that such expert testimony is used in only a limited number of criminal prosecutions. He cautions that the polygraph could be used extensively with no visual way of proving the results of the findings to the jury except by the verbal statements of the examiner. Therefore, if the tests were invalid, the jury would have no means of drawing their own conclusions in contradiction of those expressed by the expert witness.\textsuperscript{17}

Adria G. Kaplan, a dedicated exponent of polygraph evidence, rebuts Mr. Koffler's argument. He feels that "...once it is established that lie detector evidence is not used for identity purposes it does not follow that it is not circumstantial evidence, nor that it should be judged by a different standard for admissibility.\textsuperscript{18}

For the most part, polygraph examiners as well as prosecutors and police officials feel that the results of polygraph examinations should be admitted into evidence only insofar as they tend to prove or disprove the credibility of witnesses. In the words of William Wicker, "The examiner should never be allowed to testify as to the guilty or innocence of an accused. His statements must be limited to the issue of credibility based upon the subject's body responses to the questions asked."\textsuperscript{19}
At the present time, the best legally acceptable lie detector is a thorough and searching cross-examination by adept counsel. Such an adept defense counsel as Melvin M. Belli feels that cross examination is not exactly a scientific, or even reliable, process for determining the truth in criminal cases. In some instances he feels that fright, rather than mendacity precludes the truth, which is precisely the same argument many make against the veracity of the polygraph.20

In an article published in the Vanderbilt Law Review, Melvin Belli and Jack Streeter state that once the validity of polygraph tests is established they should be required and admitted in all criminal cases. Furthermore, they contend that both the court and the prosecutor should be permitted to comment upon a suspect's refusal to take such a test. In their own words, "There can be no reason for refusing to take a lie detector examination except fear of detection."19 This attitude that refusal to be examined infers guilt is one of the assumptions that opponents of the polygraph find exceedingly repugnant. Such a comment during a trial for the purpose of impeaching a witness might be condoned, but if made in reference to an accused, the United States Supreme Court would probably hold it amounted to a denial of due process of law.21 In closing, Belli and Streeter state that, "The lie detector cannot supplant cross-examination, nor should it substitute for jury deliberation. It is, however, an adjunct to determining truth, not advantageously employed under present day trial methods.22

Regarding cross examination, opponents of the polygraph often object to its admissibility on the grounds that it cannot be cross-examined. Again, however, William Wicker denies this claim. He feels that this argument is no more valid in respect to the polygraph than other facets of scientific evidence where an expert witness is allowed to testify as to his opinion concerning facts gained by use of professional instruments.23

Two other arguments are frequently made in opposition to general usage of the polygraph. First, the danger that prosecutors would rely too heavily on the device during the investigative stage and subsequently try only those who indicated that they were lying. If a test happened to be invalid the suspect's rights would have been as flagrantly abused as if the test results were admissible in the courtroom. On the opposite side of the ledger, if a defendant was allowed to introduce polygraph evidence only if it were favorable to him, it could also be an affront to justice if the examination happened to be invalid.24

In November, 1958, the Chicago Bar Association's Committee on Criminal Law terminated an eighteen-month study of the polygraph and its role in the administration of criminal justice. While
extremely broad in scope, their conclusions are pertinent in assessing the general outlook of knowledgeable legal minds in respect to the polygraph and its place in the courtroom. The Committee made the following conclusions: 1) The polygraph has a place in the detection of crimes because of the psychological effect upon persons who are in fact guilty of crimes; 2) there may be from 5-30 per cent error in test results depending upon the ability of the operator as well as other factors; 3) unqualified operators can cause unnecessary injury to innocent persons; 4) refusal to take a polygraph test should have no bearing upon the presumption of innocence; 5) the polygraph is not a substitute for the competent detection and investigation of crimes; 6) no trend should be established that would dispense with the presumption of innocence and substitute the results of a polygraph examination, the accuracy of which depends almost entirely on the ability of the operator, and 7) due to its fallibility, the results of polygraph examinations should not be admitted as evidence in court cases. 25

This stand of the Chicago Bar Association is quite significant, for it is indicative of the fact that most of the reluctance to admit polygraph evidence stems more from the fallibility of the operator than from lack of general scientific acceptance of the principles involved in the polygraph concept. The number of unqualified examiners and the lack of uniform procedures for interpreting test results seem to be recurring themes of those who object most strenuously to the use of the polygraph in the courtroom.

Overcoming an almost unsavory image is important if the American courts are to accept the polygraph examiner as an expert witness in criminal cases. To accomplish this, further investigation and research to improve polygraph techniques is necessary. The enactment of a Model Expert Testimony Act would also be beneficial. Most important, however, an adequate and nationally enforced code of professional ethics and standards must be adopted to regulate the licensing and subsequent conduct of polygraph examiners. Until these measures are accomplished, the road to court recognition of the polygraph will be long and hard.
REFERENCES CITED


8. Ibid., p. 739.

9. Ibid., p. 740.


11. Ibid.


17. Koffler, op. cit., pp. 149-152.
NEW DEFINITION OF CRIME

The Bulletin of the Canadian Criminology and Corrections Association (55 Parkdale, Ottawa, Canada) recently published an item from the meeting of the Council of Europe's Conference of Directors of Criminal Research Institutes. A new definition of crime was attempted which stated that crime should be confined to acts genuinely disturbing the life of society. Acts such as shoplifting and passing fraudulent checks should not be seen as real crime, while such things as pollution and the invasion of privacy would be. They stressed the relativity of the very concept of offence, which varies according to place, time and the status of the person concerned, and suggested that the moralistic attitude o crime be replaced by an objective consideration of the interests of society.
A COMPARISON OF CONTROL AND NON-CONTROL QUESTION TECHNIQUES

By Kenneth L. Haney
San Diego County Sheriff's Department

Although the language may differ in some detail when various schools define a control-type question, there seems to be general agreement as to the essence of what constitutes a control question.

For example, on page 14 in the Third Edition of their Lie Detection and Criminal Interrogation Inbau and Reid state, "The purpose of this question (control) is not to get the full truth about the 'control' situation, but rather to have available a question to which the subject will actually lie. This will supply a reaction for comparison with the reactions to the questions regarding the principal offense itself."

In the Keeler Polygraph Institute Training Guide published in 1964, a control question is defined as, "A question to which you believe the subject will lie and to which you know, or can reasonably infer, the answer. The control question is used for comparison purposes to determine deception in answering relevant questions or to establish the subject's 'lie pattern.'"

Even though these definitions seem comparable, controversy exists as to what use should be made of control-type questions.

In a lecture to the Fourth Annual Seminar of the Keeler Polygraph Institute Alumni Association at Chicago, Illinois, in September, 1967, George Lindberg elaborated on the Reid Technique. Essentially, he said that even though the definition leaves out all the important fine points which make the Control Question work it is still the very heart of the Technique.

In notes taken at Keeler Polygraph Institute in 1958 regarding a statement of policy by Leonard H. Harrelson, President, he said, "It is impossible for any one to predict what the psychological impact any selected so-called 'control question' is going to have on a given subject. I don't care if you do know the answer in advance. I don't care if you can be sure the subject is going to lie to the question; this still does not give you a true objective 'lie pattern,' and when you use these questions and measure the intensity of the reactions on these so-called 'control questions' against the subject's reactions to other questions, and more specifically the reactions to the relevant questions, you are going to make some mistakes in your diagnosis. I believe in using these type questions for interrogation levers and wedges--nothing more."
In this regard, however, it is interesting to note that in the training class at Keeler Polygraph Institute in 1958 the polygraph trainee was told he must establish in every polygram the subject's ability to react. It was pointed out that a subject's ability to react may be established without the specific use of a control stimulus and where this happens there is no necessity for using it. It was said that a subject may react specifically to announcement of the test beginning or to one of the relevant or irrelevant questions or a combination of these. Control stimulus devices were said to be such things as voice inflection, ambiguous questions, questions with a double meaning, compound questions, or accusing questions.

Control stimulus devices were said to be such things as voice inflection, ambiguous questions, questions with a double meaning, compound questions, or accusing questions.

It appeared that while semantics might differ, there might be no real difference between what proponents of control-type questions were advocating and those who seem to so vigorously oppose their use. In fact, it appeared that there might be more similarities between the two schools than differences.

The Comparison Tests

To test this hypothesis, one hundred subjects were administered two examinations. At the very outset each subject was told he would be given two examinations. These examinations were administered and results collected from 1965 to 1970. Results of each examination has been confirmed either by confession or outside investigation.

In each case, the first examination administered to these 100 subjects was a typical I-R test and did not contain any control questions. These questions were never reviewed with any of the subjects prior to the examination. A typical question series is as follows:

1. Is your true name John Henry Jones?
2. Are you now ___ years of age?
26. To the best of your memory have you told me the complete truth here today?
27. Have you considered any possibility about who might have taken the money reported to be missing from the safe?
4. Are you legally and happily married?
28. Do you know for sure who took the money reported to be missing from the safe?
29. Did you yourself take any of the money reported to be missing from the safe?
9. Do you now possess a valid California driver's license?
30. Did you know the money was missing before your boss asked you about it?
31. Do you know where any of the missing money is now?

No comment was ever made to a subject following first test as to what it indicated.

In each case, the second examination administered to these 100 subjects was the "you" phase of the Backster Zone Comparison test which contained control-type questions. In each case, these questions were reviewed with each subject prior to the examination. The typical question series is as follows:

13. Were you born in the state of _____?
39. Regarding the missing money, do you intend to answer truthful each question about that?
25. Are you completely convinced I will not ask you a question during this test that has not already been reviewed with you?
46. Between the ages of ____ and ____ , do you recall stealing something from someone who liked you?
33. Did you steal the money reported to be missing from the safe?
47. During the first _____ years of your life, do you recall lying to someone who trusted you?
35. Did you carry the stolen money from the store?
26. Is there something else you are afraid I will ask you a question about even though I told you I would not?
41. Regarding medication, are you holding back information about any pills or medicine you have taken during the last 8 hours?
44. Regarding other tests, are you holding back information about any other time you have taken a lie detector test?

At the conclusion of the second examination, the subject was interrogated if this were indicated by the examinations.

A comparison was made between results obtained in the first (non-control) question series with that of the second (control) question series. In each case, responses to the main target question (29) on the first non-control series were compared with responses on the main target question (33) of the second control series. Notations were made as to whether or not there was deception criteria to one or the other, or to both, or to neither.

The second comparison was not quite so simple or direct, but still coincided with theory espoused by both schools. In this case, the second control question series was checked first for response at either control question (46, 47) and appropriate notations made as to response or lack of it. The first non-control
question series was then checked to see if any point of comparison could be developed either at the announcement of test beginning, to irrelevants, or announcement of test ending. Results obtained are outlined in Table I and II.

### TABLE I

**Truthfulness Confirmed by Outside Investigation and/or Confession of Person Responsible**

<table>
<thead>
<tr>
<th># Cases</th>
<th>SR to 29</th>
<th>SR to 33</th>
<th>SR to I, etc.</th>
<th>SR to C.Q.</th>
<th>Are Results Obtained in Agreement with Theory?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
<td>Test 2</td>
<td>Test 1</td>
<td>Test 2</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Both Control and Non-Control</td>
</tr>
<tr>
<td>4</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>In Non-Control Only</td>
</tr>
<tr>
<td>1</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>In Non-Control Only</td>
</tr>
<tr>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>In Neither Case</td>
</tr>
<tr>
<td>1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>In Neither Case</td>
</tr>
</tbody>
</table>

### TABLE II

**Deception Confirmed by Outside Investigation and/or Confession of Person Responsible**

<table>
<thead>
<tr>
<th># Cases</th>
<th>SR to 29</th>
<th>SR to 33</th>
<th>SR to I, etc.</th>
<th>SR to C.Q.</th>
<th>Are Results Obtained in Agreement with Theory?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test 1</td>
<td>Test 2</td>
<td>Test 1</td>
<td>Test 2</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Both Control and Non-Control</td>
</tr>
<tr>
<td>1*</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Both Cases</td>
</tr>
<tr>
<td>4</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>In Non-Control Only</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>In Control</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>In Control</td>
</tr>
<tr>
<td>3*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>In Control</td>
</tr>
<tr>
<td>11</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>In Neither</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>In Neither</td>
</tr>
<tr>
<td>4</td>
<td>No</td>
<td>Yes</td>
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<td>Yes</td>
<td>In Neither</td>
</tr>
<tr>
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<td>Yes</td>
<td>In Neither</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>In Neither</td>
</tr>
</tbody>
</table>

* Confirmed by outside investigation. All others in Table II confirmed by confession. SR=specific response; Q=question; C.Q.=control question; I=irrelevant.
Conclusions and Observations

For this sample, non-control techniques were successful 70 times and control 68 times. Non-control did not work according to theory 30 times and control failed to work 32 times.

It may be that advocates of control-type questions could make the legitimate claim to examiner bias in this study because of initial training received at Keeler. They might also argue successfully results obtained here are due to the fact that examiner did not really understand "all the fine points" of control question technique. It may come as a shock to those who have never subjected their own technique to some analysis of just how often they are right and wrong to discover a margin or error in the technique described by these tables. It is suspected that proponents of both control and non-control techniques would hasten to say that neither of their techniques were exploited to their fullest by this kind of study, and they might be quite right. The truth of this may be solved by a much more sophisticated approach.

These results were never subjected to statistical analysis because of the size of the sample was so small it may have lacked in representativeness of the total population on which to base generalizations. In view of the fact that this sample was collected over a five-year period and only confirmed cases were selected for report, randomness of the sample might be suspect.

Empirically, it might be said there is little advantage of one technique over the other. It would appear, that both control and non-control techniques work part of the time and neither work all of the time. A much larger sample with random selection guaranteed, and subjected to statistical procedures, is needed before this issue is layed to rest.

In addition, it is suspected there are different levels of success and failure obtained from one examiner to another, regardless of whether or not they are proponents of control or non-control techniques. It may well be that the examiner with a more highly developed sense of intuitiveness, who is capable of making accurate subjective analysis of behavior he witnesses, and one who is adroit in interrogation, may well be the more successful examiner. All this, of course, should be subjected to study at some future time.

While this study is hardly definitive and can only lend some direction to thinking, examination of the literature enables one to firm opinion a bit more on the control/non-control controversy.
In a footnote (16) on page 14 in the Inbau and Reid book it is written, "In some situations the examiner may be fortunate enough to have in his possession certain information about the subject concerning a less serious offense than the one under investigation, and the examiner knows or feels reasonably sure the subject will lie about it" This is couched in rather tenuous terms and may indicate that regardless of all claims made to the contrary, these advocates have no actual proof of exactly what the control question will do for them in a given situation.

In addition, when they speak of "the nature of the subject's deception responses, etc." one wonders what exactly they are talking about in light of practical experience. It is not an experience too out of the ordinary to examine an individual who may react deceptively in the cardio in his first test, but in the galvo in his second. Neither is it too far out of the ordinary to find a person who gives deceptive responses in the cardio to one question, in the pneumo to a second relevant, and to cardio and pneumo to a third relevant question, all in the same test.

In his speech, Mr. Lindberg spoke of "all the important fine points which make the control question work." Since we were not told about these important fine points, we are left with something of a mystery and little opportunity to submit whatever this is to scientific analysis. What is needed is a formalized body of knowledge, based on research, to support advocates of this or that technique and to answer critics of polygraphy. In his speech, Mr. Lindberg also said, "That if he (subject) is more concerned about his answer to a properly constructed Control Question than he is about his answer to the Pertinent Questions, he must be telling the truth. On the other hand, if his charts indicate stronger responses on his answers to the Pertinent Questions than those on the Control Question, he is not telling the truth." Each school makes some similar statement when they talk about comparing responses to this or that question. Obviously, they are talking about kind and magnitude of response.

Those who advocate Control Question technique admonish that a Control Question should not be of greater consequence to a subject than the actual area under investigation. Without some clear proof of how to go about this, one must be inclined to agree with Mr. Harrelson when he asks somewhat acidly just how anyone is to predict the psychological impact of any given stimulus, call it control or what have you. However, Mr. Lindberg states that "If the examiner cannot arrive at a Control Question, the subject's answer to which he feels reasonably sue is a 'known lie,' he should settle for one which will cause the subject to think or be concerned about his answer." In reality, Mr. Lindberg seems to be describing exactly what the Keeler manual
describes as a control stimulus, and its use is advocated at Keeler. In examining criticism leveled at control-type questions, one can hardly quarrel with the statement, "It is impossible for anyone to predict the psychological impact of any selected so-called 'control question' is going to have on a given subject."

It would appear that not only is the statement regarding the impossibility of predicting the psychological impact of a control question true, but it goes beyond that. It can be said this is also true of any question, control, relevant, or irrelevant. This is born out by the fact that all schools of thought point out to their trainees that a so-called irrelevant questions such as, "Do you ever smoke"? may produce responses consistent with deception criteria if the individual has been cautioned by his doctor to cut down due to high blood pressure, or if he himself is worried about cancer, etc. However, just because an examiner is not able to predict the psychological impact of a control-type question does not seem to be a valid argument against its use. If it were, we would quit using questions of any type and give up this kind of testing. Most of us do our best during the pre-test to eliminate outside factors and extraneous matters which might conceivably produce unwanted responses, ones that are difficult to interpret, and otherwise interfere with examination results.

After ruling out as many such possibilities as possible, the very reason that we do test via the polygraph is to find out just what the so-called psychological impact will be to the various kinds and classes of questions in a given test series. Then we attempt to resolve these responses by means of interrogation or further testing.

Most polygraph examiners recognize they have a margin of error just as any endeavor has, but they have also collected sufficient "clinical" evidence to indicate their technique has efficacy, probably at least equal to that of medical diagnosis, psychiatric evaluation, and other accepted diagnostic methods of human behavior.

The one striking similarity referred to by all systems is the search for a point of comparison, regardless if they call it control, or some other name. Each system also speaks of "strength of response" which can only mean a change in the tracing and the magnitude of that change.

Observations on Polygraph Technique

First of all an earnest attempt is made to establish a relationship with the subject in which the truthful person feels
comfortable and the untruthful increasingly uncomfortable. "Rights" per Miranda are explained.

The attempt is made to orientate subject for time and place. His intelligence level is estimated. Gross personality and emotional disorganization is checked to rule out possible psychotic functioning. Verbal projective devices are attempted to elicit the "acting out" usually characteristic of the psychopath. Attempt is made to rule out factors which would prevent subject from being suitable for exam. An explanation of how the test works is given. Subject is invited in narrative to describe what he knows of events under consideration. He is caused to repeat events by detailed question and answer. Questions are formulated and attachments are placed on the individual. Subjective analysis as to truthfulness or deception is made throughout the interview.

During each examination the attempt is made to demonstrate a subject's ability to respond. If he responds to nothing, it could indicate he is telling the truth, but it could also indicate he is incapable of response. At any rate, the attempt is made to elicit the manifestation of a response. This may be done as a result of the announcement of test beginning. It may come as result of an "irrelevant" question. It may come via a control question.

Once it is established that the person is capable of response on that particular chart, internal consistency within that chart is checked. In other words, if the individual responds to announcement of test beginning and during the later part of the examination to an irrelevant or control or to announcement of ending of examination, he has shown capability of response, has not responded to any relevant question, and the test is said to have an internal consistency. In the event the person does not respond particularly well to any of the irrelevants or to a control but does to the main target question, internal consistency is established. Kind and magnitude of a response becomes the point of comparison, then consistency is checked.

Responses may or may not be resolved by interrogation following the first examination depending on the situation.

A second examination, usually employing a different technique, follows. Again, the point of comparison is established by kind and magnitude of response. This is compared with responses to all other questions for internal consistency. These results are then checked against the first examination. If the subject is shown to be capable of autonomic response in each chart; if there is internal consistency within each chart; if there is agreement between charts; then examiner may feel comfortable in his
diagnosis. He need not concern himself with nor embroil himself in the controversy as to whether he will call a given question “control,” just as long as that type of question works.

It is my personal conclusion that each polygraph examiner should work with that technique he feels most comfortable with, to achieve his greatest possible success. He should try and experience all techniques and methods available to him, and be adaptable enough to use the one which holds out the greatest chance for success in each individual case.

APPENDIX

A LIST OF THE 100 CRIMES SUBJECTS IN THIS STUDY WERE EXAMINED FOR

- ARMED ROBBERY 5
- ARSON 5
- BATTERY 2
- BURGLARY 15
- CONSPIRACY 1
- DRUNK DRIVING 2
- FORGERY 2
- GRAND THEFT 8
- HIT & RUN 4
- INCEST 2
- INDECENT EXPOSURE 4
- L & L WITH CHILD 5
- MALICIOUS MISCHIEF 1
- MURDER 3
- PATERNITY 3
- PETTY THEFT 10
- POSSESSION OF NARCOTICS 4
- RAPE 3
- SEX PERVERSION 2
- SLANDER 1
- SMUGGLING DRUGS 4
- SMUGGLING LIQUOR 1
- SMUGGLING NARCOTICS 4
- SOLICITING AND ACCEPTING BRIBE 3
- VICTIM'S VERACITY (AUTO THEFT) 1
  - " " (CHILD MOLEST) 1
  - " " (KIDNAP & RAPE) 1
  - " " (RAPE) 1
  - " " (ROBBERY) 1
- WINDOW PEEPING 1

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THE POLYGRAPH: LABORATORY vs. FIELD RESEARCH

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The literature has consistently indicated a divergence of opinion between the findings of polygraph researchers and polygraph examiners. Each group tends to disregard the findings of the other. Polygraphers have criticized laboratory studies on the basis of there being little fear of detection associated with an acted-out crime. As Berrien (1) pointed out, the laboratory subject has little to lose as compared to a suspect in an actual crime who faces possible imprisonment. In agreement with this, Trovillo (2) stated that the "drastic stress" is simply not part of the experimental situation. This does not imply that lie detection cannot be accomplished with any large degree of accuracy in a research situation, as high validity has been attained (3,4), but only that the degree may not be as large as in a real crime situation. Levitt (5) stated that both artificial and real crime situations evoke emotional responses but the nature of the specific responses may be quite different. In researching this, Gustafson and Orne (6) demonstrated that the more motivation to deceive, the more readily lying was detected.

Validity above 90 per cent in actual criminal investigations has been reported (7,8,9). Lykken (10) stated, however, that there are no published accounts of properly conducted studies to verify this and that experiments conducted under artificial conditions do not produce validities "nearly so high." Highleyman (11) questioned the high percentages of accuracy reported on the basis that these findings were predicated upon tests conducted by experienced examiners under the most favorable conditions. He indicated that under "more normal conditions" there is far less accuracy. His conclusion was that the disagreement between "authorities and examiners" has resulted, in part, from a lack of sufficient clinical data which preclude any final statistical evaluation.

Polygraph 1972, 01(3)
The dilemma of research into the polygraph is all too obvious. According to many, laboratory studies cannot simulate the emotional reactions of a criminal suspect, but also, polygraph examinations in real crime situations cannot be completely verified and a controlled investigation cannot be carried out.

The author carried out research on the polygraph, and after completing two studies (12,13), enrolled in a polygraph school. It was in this situation that a comparison was made between the two groups.

For the purpose of training, a large number of subjects was provided to act out crimes which the polygraph students were to attempt to detect. Situations were developed to make the crime as realistic as possible in order to obtain as much emotional response to lying as possible. An example of this was a twenty-year old woman being instructed to set a gasoline fire in a waste can outside the training area. Unknown to her, a fireman was stationed nearby. He ran out with a fire extinguisher, put out the fire, and chastised her verbally for the act. It was assumed that a strong emotional response would result from such actions, making the mock crime as real as possible. Afterward, she was brought into the school for examination, and the students were told to determine if she had committed a crime, and if so, which one. The students were given a list of six possible criminal acts and asked to determine in which, if any, she had been involved.

In spite of all efforts to make the crime as real as possible, the ability to accurately determine lying varied dramatically from subject to subject. In some individuals, lying clearly indicated that much was lacking in their responses.

This was more graphically demonstrated when the same students evaluated truth and deception on the charts of suspects of actual crimes. There was not the least question of the ease of interpretation of the real records, in contrast to the actor subjects. The students, of which this writer was one, showed a high degree of accuracy. With the course only partially completed, accuracy ranged from approximately 85 to 100 per cent. Moreover, reliability was consistently high, with not more than one of the twelve students disagreeing on the guilt or innocence of a particular suspect.
To this writer, the difference in responses between the individuals who had committed real crimes in contrast to acted out crimes was great. This could account for the discrepancy between the reports of the accuracy of polygraphers versus experimentalists. Consider the crime situation created for the actor subject related earlier to the following real crime situation. A woman was accosted in a park, raped, and viciously mutilated. Afterward, she was killed by repeated blows to the head with a rock. The rock and her bloody, torn dress were discarded in a trash can. The suspect was presented a peak of tension test in which he was asked if the woman in the park was killed with a knife, a gun, a rock, a branch, or a rope. The actor subject was asked, "In the last hour have you been involved in a burglary, a battery, an arson, a car theft, or a robbery?" Now consider the consequences of being detected in the two instances. For the murderer, possible life imprisonment. His very life is being wagered against his ability to control his heart beat, blood pressure, respiration, and his electrical skin resistance. He literally bets his life, but what fear, anxiety, or guilt does the actor subject feel, since he has little at stake?

An interesting subjective impression perhaps further illustrates the emotions associated with the risk involving detection in a lie. One instructor offered to examine one of the students in an effort to determine the name of the student's wife. The student only had to conceal his spouse's name among five others and respond with a "no" when asked on at a time if this were the correct name. The writer, with a degree of assurance, volunteered. The instructor added, however, that he wanted to wager fifty dollars on the outcome. This dramatically altered the situation and in turn the writer's emotional response. These feelings actually could be experienced. The fear of detection now became apparent and all the confidence of being able to "beat" the polygrapher disappeared. Now there was involvement and something to lose. If this feeling could be so actively experienced with the risk of losing money, one could readily imagine the effect when the penalty for detection is imprisonment.

While the major difference between these two groups of subjects lies in their physiologic response, as it related to the degree of stress, there are other significant differences. In the majority of publications there is no indication as to how many charts had been run on each laboratory crime subject. In an actual crime situation, the number of charts is determined by the information available on the crime and the findings obtained on each chart. There may be twenty or more charts,
and if any doubt still exists, the suspect may be called back for another complete examination on another day. Moreover, in an actual investigation the polygrapher shifts from one test procedure to another. He may start, if applicable, with a peak of tension test and then go through a zone, a general series, or any number of other approaches. The variability of tests that can be employed and the much larger number of charts administered in a crime investigation are definite aids in obtaining greater validity and reliability as compared to laboratory studies.

Another difference relates to the galvanic skin response. The literature has pointed out that in laboratory studies the GSR is the most valid measure (14,15), while it is reported that polygraph examiners see this as being of minimal value as compared to the other measures (16). This was corroborated in the school setting. Lying by the actor subjects was generally most easily detected on the GSR tracing, but it was of value only on occasion in interpreting the charts of criminal suspects. In the majority of instances it fell far below the cardiosphygmomonometer and respiratory tracings in value.

From this researcher's viewpoint, training in the polygraph dramatically emphasized the weaknesses inherent in the experimentation on this instrument. It would appear that unless some means were used to create a fear reaction comparable to that found in an actual criminal suspect, laboratory research would be of little value. Perhaps a significant money loss could be utilized if sufficient funding were available. With willing subjects, a strong electric shock might be administered each time the subject was detected in a lie (4). If enough fear arousal were evoked by this, it might approximate the anxiety associated with fear of detection in a crime situation.

The most meaningful research would be a study of the examination of actual criminal suspects. For an investigation of validity, only the verified charts could be employed, but this might well result in a biased sample. Unfortunately, there is no possible way of verifying all the charts, although in a personal communication, Reid has indicated verification of 75 per cent of the polygrams administered by John E. Reid and Associates of Chicago. Research on reliability could easily be carried out, for in this, a total sample could be used which would include both the verified and unverified charts.
It is believed by the writer that much investigation of this technique could be done by simply forwarding a large number of charts to a series of polygraphers for their interpretations. In this way validity and reliability studies could be readily carried out. There is, again, a definite weakness in this paradigm in that the examiners do not have the opportunity to observe the suspect or to develop their own tests or questions. In spite of this, it is felt that a better approximation of a real crime situation could be attained than through the usual laboratory studies.

Since all of these research techniques have definite weaknesses, the study of this approach is highly difficult. With these inherent weaknesses and the paucity of experimentation that has been carried out, the courts, in determining admissibility, have resorted to the impressions of "authorities". Surveys of professional opinions as to the effectiveness of this instrument reported by Orlansky (16) are close to meaningless. This is because only a relatively small number of these individuals have had any real contact with this approach, and the majority of these individuals have had any real contact with this approach, and the majority of these in laboratory situations. When the polygraph experts claim high accuracy, the scientists scoff because their findings are not based on a sophisticated experimental design. This writer, however, who was a researcher first and now has been trained in polygraphy, must strongly support the effectiveness of this instrument. It behooves the investigator to obtain some training or at least experience the use of the polygraph in law enforcement work. Then perhaps the experimentalist can develop a clearer perception of the polygraph and its varied uses in law enforcement, business, government, and even diagnostically with psychiatric problems. Then he can fully appreciate the intricacies of this approach and develop his experimental designs accordingly.

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The Psychogalvanometer in Deception Tests

The use of the galvanometer, or psychogalvanometer, for detecting deception, is of comparatively recent date; although Galvani, the Italian physiologist, after whom the modern instrument is called, published his paper on animal electricity in 1791. Probably the earliest suggestions for the application of psychogalvanic reactions to forensic problems came from Sticker, in 1897. Sticker was convinced that a strong emotional connection was responsible for the phenomenon:

"I have repeatedly convinced myself that the origin of the galvanic skin phenomenon is under the influence of exciting mental impressions, and that the will has no effect upon it; this reflex could be used with great advantage for the discovery of words and pictures that influence the emotions. In a word—which will be listened to by many without any reaction—whichever takes the meaning of something to heart will react with a strong galvanic skin phenomenon. Whoever is from any cause emotionally roused on looking at a picture will react with a definite increase of the current; whilst whoever is unmoved by the picture, or in whom it arouses no memory, will have no skin excitation."

Sticker's suggestions were made years ago. To those of us who are accustomed to thinking that the "lie detector" is a product of the gangster era of 1930, Sticker's proposal of 1897 may sound like a long time ago. But Sticker based his proposals on the experimental ground work of several predecessors. Adamkiewicz, in 1878, was the first to offer experimental proof that the secretion of sweat is closely linked to psychological processes. He did not show that the galvanometer measures perspiration changes; indeed, even today we do not know conclusively that perspiration changes are alone accountable for the reactions observed. However erroneously, we are accustomed to speak of the reactions as apparent changes in the resistance of the skin to an external current.
Veraguth was one of the first to make word-association tests with the galvanometer, although Munsterberg was concurrently inting to its application to criminal cases. It was Veraguth pointed out in 1907 some of the galvanic phenomena which forensic psychologists have only recently re-discovered for themselves. Our criteria of deception are only Veraguth's criteria of motion, for he noted that emotional complexes, unveiled in word-association experiments, made an ascending galvanometer curve contrasted with the "rest curve" of non-crucial stimuli, and at these personally significant stimuli produced larger fluctuations an indifferent stimuli. Veraguth also indicated that the first different stimulus words caused larger responses than succeeding different stimuli. He probably was the first to use the term psychogalvanic reflex" (1907). The term, however, is an unfortun-nate one, for, as pointed out by Rucknick, the reaction is not a flex, its psychological nature being still incompletely understood. Better term which has been proposed is electrodermal response: is term does not imply that the reaction is as specifically ated as early investigators were wont to believe, and is in ne with the current healthy skepticism as to just what the response is. Some consider the response an electrodermal indicator connected to the sympathetic division of the autonomic nervous this, or perhaps to the parasympathetic division, but the con-tions to which it is subject are not too well defined. Veraguth believed that the electrical phenomena noticed by F'ree', Tarchanoff, and Muller (both the so-called endosomatic and exosomatic currents), are attributable not to vascular changes in the skin but to tivity of the sweat glands. The mental counterpart of these ranges he ascribed to a feeling of reality or compulsion, or an emotional situation, or both. Soon thereafter, in Zurich, Jung and Peterson used the phenomenon for detection of emotional complexes.

Marston states that in 1917, he, Troland, and Burtt experimented ith a galvanometer or galvanometers for the detection of liars. his experimental work was for the Army Intelligence Service, nd was designed to discover which of several proposed techniques uld be best for application to war-time problems. The report on the galvanometer was unfavorable.

Jung, writing in 1919 gave a large bibliography for studies ade with the galvanometer, but included none specifically concerned ith deceit. In the last thirty years (or since the paper of eraguth) more than four hundred and fifty papers dealing with he so-called psychogalvanic reflex have been published. But from ells and Forbes to the contemporary contributions of Darrow, ery little actual research on psychogalvanic criteria of deception as been done. Nevertheless, Binswanger, in 1919 was able to
point out that "The analysis in many (of Veraguth's) cases discloses undoubted relationships of an 'old' complex to the present in the same way an apparently 'actual' complex which momentarily seems very much to occupy the subject, may derive its essential effect from events of long ago." Modern police interrogations which depend upon the electrodermal or psychogalvanic responses of a criminal suspect may find this very situation embarrassing. A suspect may give a large response, for example, not because he is guilty of robbing the place in question, but because he has robbed other and similar places. The operator is not always able to identify the basis for the reaction until after prolonged questioning about related or associated experiences.

Of the many modern studies of electrodermal responses, those most closely concerned with deception usually are studies of fear. Since fear is customarily the main component in suppression of the truth, there is much of criminological interest in the excellent paper by Bayley in which she differentiated between sudden fearful shock and apprehension, and showed that in the psychogalvanic technique the two could be distinguished by the immediateness of the reaction and its duration. A considerable bibliography is appended to her paper.

A promising approach to the differential diagnosis of electrodermal patterns came out of Germany in 1933. E. Enke classified the character types of her subjects at the time she secured from them the electrodermal responses. She found reactions of great magnitude and duration to come principally from the persons who were the most unstable and who had the most internal conflicts. If such types could be diagnosed in advance it might eventually be of service to the police investigator who employs the psychogalvanometer in detecting criminal guilt. Enke's results are interpreted in terms of the Kretschmer types and are suggestive of practical applications to forensic interrogation with the polygraph.

A rare combination of academic interest and forensic application is seen in the work of Summers, whose development of the "Pathometer" lately excited much interest and criticism. Although the Summers apparatus has been used in over six thousand laboratory experiments, it has been employed in only about fifty actual cases involving the question of guilt or innocence of criminal suspects. Summers stated that his "Pathometer" produced results with 98% to 100% accuracy, and the reason he did not attain perfection consistently was attributed to "the laboratory situation." Summers believed that it was "quite impossible for anyone so to control his emotions as to deceive the experienced interpreter of the records."
The Summers technique involved giving three tests and comparing the amounts of deflection of the recording pen on crucial and insignificant questions. On the final test three significant questions were asked the suspect, each three times; repetition of the question produced similar patterns of response, which differed quantitatively. A gradual diminution of amount of deflection would indicate innocence; repeated responses of equal or greater magnitude would indicate guilt or guilty knowledge. The apparatus in use measures the apparent conductivity of the subject, or his apparent resistance to the passage of an external current measured in millionths of an ampere.

Bril, a consulting criminologist of New York City, worked for a time with Summers in the development of the apparatus which subsequently appeared in portable form. The "Brilograf," Pathometer was quite similar to the instrument developed by the Reverend Walter G. Summers and Jacques Bril during their earlier work. Bril's apparatus, like the Summers' Pathometer, measures apparent "changes in skin resistance."

In 1930, Wilson, of the former Scientific Crime Detection Laboratory of Northwestern University School of Law, built a non-recording galvanometer, and in 1931, he and Keeler used it in several investigations of criminal suspects. In 1930 he developed a manual recording device which enabled the operator to record the response simultaneously with those of blood pressure and respiration. In 1935, Wilson designed and built an improved recording galvanograph, putting it into service in June, 1936. This apparatus consists of resistance elements constituting a Wheatstone bridge. In order to find the effective value of resistance in the unknown leg of the bridge, one of the ratio arms is arranged so that the standard resistance, which is continuously variable from 0 to 50,000 ohms, must be multiplied by factors of .5, 1, and 2. The null type of indicator is used in the conventional manner. A meter is used for balancing. When the instrument is to record electrical changes in the subject, or X leg of the bridge, a General Electric photoelectric recorder is substituted for the galvanometer. This recording device has a full range sensitivity of thirty-three microamperes. A recording fountain pen traces the deviations from original setting, and these appear on the same paper chart which records changes in blood pressure, pulse, and respiration. Included in the control cabinet of the galvanometer is a sensitivity control and a microammeter to indicate the amount of current flowing through the tissues of the subject. Electrodes wet with a zinc sulphate solution (or a solution of sodium chloride, which has also been used) are attached to the palm and back of one hand.
In recent studies at the Chicago Police Scientific Crime Detection Laboratory the electrodermal responses of criminal suspects under test have been correlated with cardiac and respiratory indices of deception, and we submit certain tentative criteria. These patterns include: (1) Relatively larger magnitude of response during deception than on non-significant questions; (2) Greater area of response in deception than on non-significant questions; (3) A gradually ascending electrodermal response, as an accompaniment of prolonged nervous excitation (in contrast to a gradually descending response accompanying relief of tension). (Ascent of the line, as recorded in the polygraph record, indicates increase of conductance of external current between palmar and dorsal surfaces to one hand); (4) The last comparatively large fluctuation (only during a control test in which but one of several responses is a lie); (5) A fluctuation having an angle of about 45°, a gradual not a sharp and instantaneous change. (We find that shock stimuli or sensory stimulation such as loud noise, slap on cheek, or thumping of ear lobe, tend to beget a sharp deflection. These are in contrast to such ideational stimuli as are usually involved in repeated questions about a crime scene); (6) Pattern at point of deception may be considerably different from that at any other place in the test. This pattern may involve a deflection of unusual magnitude, or it may consist, indeed, of an absence of deflection; (7) Duplication, on repeated tests, of pattern appearing in first test. This may also involve a similar magnitude of response, in contrast to decreasing magnitude for innocent subjects.

A the present time (1939), although we have found the electrodermal responses very helpful in experimental cases (providing interpretations about 95% accurate), nevertheless in actual case work they have not been of consistent service. It may be that further research will modify our current position.

Miscellaneous Objective Measures

It is possible today, for objective investigation of deception to utilize many different techniques and approaches. C. W. Darrow, on the basis of considerable experimental work, takes the position that electrodermal changes are indicative of changing states of alertness and adjustive activity, whereas the blood pressure increase is generally identifiable with some disturbing or disrupting influence. "Deception, unmotivated by demands of self-defense, is but poorly betrayed in the blood pressure records and characteristically productive of increased blood pressure in normal persons when these words were 'disturbing' or 'embarrassing." He develops a theory that active conflict releases from cortical control the sub-cortical mechanisms of excited emotion.13
The most common objective measures have already been discussed. Others, including some not yet employed for this purpose, are available and offer fertile field for research. If we were to arrange an arbitrary classification of the phenomena which have been demonstrated to have some correlation with emotion we might divide them into involuntary responses, semi-involuntary responses, and voluntary responses.

Involuntary responses include the changes induced by emotion in blood pressure (systolic, diastolic; pulse pressure), pulse rate, blood volume, blood vessel dilation. The following phenomena influenced under emotion, offer further possibilities for gauging the fear associated with deception: blood calcium, acidity of the blood, blood counts, cellular contents; nitrogen excretion, spleen and stomach contraction, gastro-intestinal tone and activity, hydrogen-ion concentration of the saliva, the urine, and the perspiration; glandular dysfunction; bladder movements; electrodermal changes; alkali reserve. Besides these, one may eventually be able to measure more objectively the influence of external color, and meteorological influences of humidity, barometric pressure, and temperature, on emotional states.

Semi-voluntary responses pertinent to studies of deceit include respiration volume, inspiration-expiration ratios, metabolic rate, regularity and rate of breathing; association of words and ideas; facial expression, speech vibrato, motor reaction, and reaction under such narcotics as scopolamine.

Voluntary responses include body posture, individualized movements of arms, hands, fingers, feet, legs; speech--its volume, inflection, tone, enunciation, and pronunciation; expression in the eyes ("eye light," reflecting mood, health, and attitude); general facial expression, including simulated emotion.

Two outstanding background books for the criminologist are Hans Gross' Criminal Investigation of 1907, and Hugo Munsterberg's On the Witness Stand of 1908. In the latter one may find reference to the application of many psychological principles to detecting guilt. Munsterberg proposed to adapt a number of psychological instruments to a variety of bodily functions to make accurate records of the processes of emotion. Not only did he suggest that blood pressure and pulse tracings could have forensic importance; but he pointed in detail to the utility of respiration records; posture and movement records; eye movements, plethysmographic records of blood circulation; electrodermal resistance measures (using the galvanometer); variations, during emotional stress, of the knee jerk; changes in body temperature; and lastly, he showed how with the examination of criminal suspects the word association test could be quite valuable in diagnosing guilt. Munsterberg
apparently made few criminological applications; the chief virtues of his articles prior to 1908, and his books following 1908, lay in the unusual insight he had of the manner in which common psychological instruments, already in use for years around the world, could be applied to forensic problems.

Word Association and Motor Movement

The idea of measuring the self-control of subjects during emotional stress was applied in 1923 by a Soviet psychologist, A. R. Luria, to the trapping of criminal suspects.14 By examining murder suspects prior to interrogation by the police he had a high degree of success in securing confessions. The technique requires an especially prepared word-association list and apparatus for the recording of voluntary and involuntary movements of the hands. When a word is spoken the subject is to reply with another word, either the first word that comes to mind or one that satisfies a pre-arranged relationship, simultaneously pressing one hand on an actuating mechanism. The fingers of the other hand rest on another unit which receives any delicate tremors occasioned by disruption of the normal regulating processes. Thus a double check of motor responses is obtained. Reaction times are recorded. Disturbances of patterns of manual response, plus irregularities in the reaction and response-time, constitute criteria for the disintegrating influence of emotionally dominating stimuli. Luria's theory posits the breakdown, during emotion, of motor control, and the revelation of associative connections in the speech system. Although the idea is not new,15 it has stimulated research in this country. Runkel, in 1936, made investigations wherein he appears in substantial agreement with the results of Luria.16 In the same year H. Burtt, with assistance of Camp, reported a similar research,17 wherein he said: "It is suggested to the crime detectors that while the association reaction has been considerably overshadowed by blood pressure, and so forth, it would be profitable to give it another try, using this supplementary manual technique." The apparatus described by Harold E. Burtt, then Chairman of the Ohio State University Department of Psychology, records in ink blood pressure, respiration (two curves), time in seconds, verbal stimulus and response (as recorded by a magnetic marker operated by the voice), and involuntary and voluntary reactions of the hands. Cuff pressure of only 40 millimeters of mercury is sufficient to actuate the blood pressure unit, which consists of a chamber containing a metal bellows. The chamber itself is under the same pressure as the cuff and bellows and a valve permits the blood pressure to affect the bellows alone. Motion of the bellows is transmitted to a marking pen through a thin, warped, steel diaphragm.
Other Possibilities

Other possibilities exist for the criminologist interested in recording deception. As Moore said in 1917, fear can be the most disintegrative influence of all thought stimuli; and so it should not be too difficult to detect if only we are sufficiently interested.\(^{18}\) For years we have known how fear robs the human voice of its normal even tenor; now we can measure objectively its influence on the voice.\(^{19}\) We have even come to inspect the electrical activity of the brain. Indeed, C. E. Obermann of the University of Iowa reports success in detecting lies by means of brain potential patterns.\(^{20}\) And, although we may never be able to objectify the shifting tension and relaxation of the facial musculature, many have tried it, some even for deceit.\(^{21}\) Furthermore, we are able to employ drugs such as scopolamine, sodium amytal, and chloroform in a number of therapies, but there is only a limited opportunity in the use of narcotics for crime detection.

Theoretically, still other measures may be found for detecting deception. And the more means we have at hand to objectify our interviews with suspects, the more we may expect to come to a correct interpretation of their status. For some people react under stress in one way, some in another, and we have not yet advanced to the point where we can predict which of the body processes of any person will be most disrupted by emotion. If we could, our investigations would be easily and quickly concluded, for we could then select the weak spot in the system for analysis. We are at least certain today that fear of detection may on one person heighten the blood pressure, yet not disturb respiration or the electrodermal responses; in another person, it may effect only the respiration, or only the electrodermal reaction. Still others under tension may be able to look the examiner straight in the eyes without blinking, yet reveal their emotion by repeated coughing or movement.

It is to be hoped that the passing of the day of the pioneers in this field will be only a stimulus for a fresh approach. We have had much quibbling heretofore as to who was the inventor of the "lie detector" and as to who has the best method. We now realize that here is no one "best method," no one inventor, but many methods and many inventors. The scientific approach, the analysis, sifting, and classification of evidence derived under controlled circumstances, utilizing actual criminal suspects as case material, will encourage new workers to enter the field.
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CODING OF GSR DATA

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ABSTRACT

The coding of GSR data for statistical treatment is examined under the heading; (a) selection of data points, and (b) coding the differences among data points. Data points must be selected to extract valid conclusions from the data. The most generally valid way of then coding the scores is to report the data points in terms of absolute skin conductance at each point. Other methods of coding can be valid in specific circumstances. Descriptors: Electrodermal analysis, GSR analysis, skin conductance theory, skin resistance analysis.

Coding will be treated under two main headings: (a) selection of measures points; and (b) coding the differences among data points. Each of these two headings will include discussion of various possible procedures, from the standpoint of extracting valid information from the data.

Selection of Measures

GSR amplitude (i.e., vertical displacement on the chart) has repeatedly been found more meaningful and dependable than a number of other derivative scores, e.g., latency. Amplitude, accordingly, is the most frequently used response dimension. However, it is not a simple measure. In the case of responses to brief, discrete stimuli, the GSR is typically very distinct and the degree of vertical displacement seems to be easily defined. The GSR is much harder to define when complex stimuli are used, or when the stimuli are of long duration. The GSR may show multiple peaks widely separated in time. In addition, with any kind of stimulus (and commonly if the stimulus is noxious) the chart may fail to return to its pre-stimulus level, and the resulting chronic GSR may be a meaningful part of the response. Therefore, the use of response amplitude requires careful thought about: (a) the stimulus changes to be manipulated, and the probably meaning of the resulting responses, and (b) whether or not chronic effects of the stimulus changes may have important meaning.
in the research project. There is one other important characteristic of GSR amplitude. By definition, the response is a difference between a post-stimulus data point and a pre-stimulus data point. The discussion under the main heading "Coding the differences among data points" is applicable to all amplitude scores.

Wolfensberger and O'Connor, 1967, suggested that response duration was a better measure than amplitude. They found that duration scores were more sensitive to subject (S) and stimulus differences, and had lower errors of measurement, than amplitude scores. Although the two types of scores were only modestly correlated, both scores had very similar relationship to subject and treatment variables. Duration scores are not obtainable, however, unless the post-stimulus record returns to its pre-stimulus level. Instances are common in which even a single stimulus presentation or stimulus change generates a chronic GSR which may persist throughout an entire experimental session. Therefore, duration scores cannot be used in an experiment if chronic responses occur. Wolfensberger and O'Connor thought that duration scores might be freer of statistical problems because the response is not expressed in terms of a change from pre-stimulus level. This advantage is not very real, however, because response duration is sometimes correlated with pre-stimulus amplitude just as is response amplitude. In addition, duration habituates over stimulus repetitions just as does GSR amplitude.

GSR duration and amplitude seem to meet the usual requirements for multiple predictors, i.e., they have fair correlations with experimental variables and only a modest intercorrelation. Some combination of the two measures might increase the relationship between manipulations and responses, i.e., might be a more accurate definition of the response. This possibility can be verified only by research. Steinschneider and Lipton (1965) reported that results were much the same using amplitude, duration, or combinations (recovery quotient, or area under the response curve). Perhaps improvements in coding of GSR amplitude data may increase the correlation between experimental variables and the data more than is possible through combinations of amplitude and duration. Not much can be done to improve duration scores, because they are single time intervals (e.g., 18 seconds). However, the coding of amplitudes leaves much room for possible improvement.

GSR frequency is often used, but large numbers of subjects produce only as many GSRs as there are significant events in an experiment, so this method of coding has limited utility.
Amplitude Units: Resistance or Conductance

Virtually all GSR recording equipment yields a chart in resistance units (ohms). However, Edelberg (1967) points out that GSR is not true ohmic resistance, and he claims that skin resistance is a derivative of skin conductance. Montagu and Coles (1966) develop a structural theory of GSR and show convincingly that conductance is the true measure. Accordingly, the nature of GSR requires that data points be reciprocated to conductance units (mhos), and that any other units must be considered to be transformations of the "original" data. The selection of units is important. It has been demonstrated that reciprocal transformation can affect the outcome of analysis of variance, analysis of covariance, or correlational analysis; therefore, the score units used must be supported by "explicit rationale" (Benjamin, 1967, p. 196). Montagu and Coles (1966), like Benjamin, insist that no transformation should be made unless it can be supported by theory. Reciprocally transformed scores are not equivalent to the original scores, any more than with other transformations, and interpretation of an analysis can be only in terms of the units used for analysis (Kirk, 1968, p. 67). Theory and "explicit rationale" support conductance units, not resistance units.

Montagu and Coles argue that biological variables tend to follow logarithmic relationships, so they believe log conductance is justifiable as a transformation when useful; it is often used (e.g., Hagdahl et al., 1967; Wolfensberger and O'Connor, 1967). Wolfensberger and O'Connor also used the log of the trial number in repeated measures and found (as other before, cf. Montagu and Coles, 1966) that log conductance regressed linearly on log trial number. The resulting linear relationship has only one advantage, however, that it simplifies regression adjustments for repeated measures. The section on "coding the differences among data points" will make it clear that regression adjustments are not valid with conductance data. Therefore, there seems to be little rationale to justify logarithmic transformation.

Reduction to Single Scores or a Series of Scores

A chart may be reduced to a single score by; (a) selecting a single data point, or (b) selecting a series of data points and calculating the mean or median. The principal disadvantage of single-score reductions is the enormous data loss that results, except in studies which present only one simple stimulus change. Analysis can therefore yield only coarse comparisons of either treatment of S differences. A coarse analysis will be at best an underestimate of differences, and
at worst a gross misrepresentation of the detailed data. Single-score reductions should be used only when it is readily apparent that they are valid expressions of the data and their use does not mask other variations in the data. Furthermore, because much data is sacrificed, single scores should not be used unless the experimental effects are expected to be clearcut.

Particularly when using a single data point, the sampling error (and, therefore, error variance) is apt to be larger than on any form of multi-point data. The single point of measurement is affected by within-subject variance which cannot be assessed or removed. The F ratio is:

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\frac{\text{Treatment variance plus within-subject variance}}{\text{Error variance plus within-subject variance}}
\]

Within-subject variance can result from such influences as shifts of thought and feelings on matters unrelated to the experiment (Darrow, 1967; Martin and Venables, 1966), and can be substantial. Therefore, the use of a single data point cannot be considered a very satisfactory procedure. Nomikos et al. (1968), Opton and Lazarus (1967), and Lacey and Lacey (1962) are examples of a point score, the single maximum conductance of the experimental period.

Calculating a mean or median from several data points has the principal advantage of reducing within-subject variance. However, care must be exercised in selecting the data points which are to be combined. The points which are combined should all have similar meaning in terms of the experiment; e.g., they should all be points at which maximal response is predicted, or all points where no response is predicted. The choice of points is therefore determined by what the mean is supposed to represent. The feature to be stressed, for using a mean or median to describe GSR data, is that the score be derived from data points having similar meaning. The clearest illustration of breaches of this principle can be seen in baseline data. Often the "baseline" is the mean or median of a one or two-minute resting interval. The graph is typically perfectly linear, except for occasional transient increases in conductance. These transient increases are usually interpreted as responses to irrelevant stimuli or to thoughts, and as such the data points do not have the meaning intended by "baseline"; they should not be included in the calculations of a baseline mean or median.

Visual inspection of GSR data is essential if we are to avoid masking of experimental effects. It simply is not possible to predict the points of a chart which will represent,
e.g., the points of maximal response. Variations in response latency, rise time, etc., make prediction impossible. Data points for each subject must be selected visually.

Lazarus et al., (1963) point out clearly that oversimplification, by taking just one or two scores per S, can give very unreliable data for analysis even if each score is derived from a coding of many points. The use of more scores per S (e.g., Lazarus et al., 1963; Nomikos et al., 1968; Taylor and Epstein, 1967) provides a basis for separating at least some within-subject variance from both the treatment effect and the error term. If the scores are independent, they can actually provide an error-within term for testing the Treatment x Subject interaction. Even if the removal of within-subject variance is not sufficient to validly test the within-subject effect, it will raise the power of the treatment test. Strangely, from all the studies that have used multi-score coding, few have tried to use their data to reduce the error term. Lacey's ALS scores, as he uses them, remove part of the S variance from the error term and transfer it to a within-groups term, but this does not enable tests of S effects. A Treatment x Subjects design is called for (Speisman, et al., 1964), but often the GSR repeated measures fail to meet the requirement of independence for such an analysis. However, even in cases of correlated repeated measures, we should not be deterred from the advantage of multi-score coding. Greenhouse and Geisser (1950) offered us a set of approximate F ratios which can be used when critical assumptions are violated.

The use of a series of scores for each S has clear advantages for increasing the validity and reliability of information extracted from most GSR research. The most useful procedure, a Treatments x Subjects form of analysis, has not been used in the GSR literature. Cases of repeated measures are being analyzed as if each repeat were an independent experiment (e.g., Nomikos et al., 1968). Better use can be made of the series of scores if it is treated as a series.

Coding the Differences Among Data Points

So far we have discussed the process of deriving data points from the skin-conductance record. However, these data points must be expressed in terms which enable comparisons to be made. Either the responses of different Ss are to be compared, or a S's differential responding to different stimuli is to be evaluated.

Certain types of data codings can be evaluated from their raw form, without further manipulation. Three types in this
category are response duration, response latency, and response frequency. All of these have serious shortcomings which have been discussed. A fourth type of coding that enables direct comparisons is the use of absolute skin-conductance level; e.g., repetitions of a stimulus to a S might yield skin conductance levels like the following (in micromhos):

<table>
<thead>
<tr>
<th>Pre-stimulus</th>
<th>Post-stimulus</th>
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</thead>
<tbody>
<tr>
<td>1st minimum</td>
<td>1st maximum</td>
</tr>
<tr>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>2nd minimum</td>
<td>2nd maximum</td>
</tr>
<tr>
<td>22</td>
<td>25</td>
</tr>
</tbody>
</table>

This method of coding uses response amplitude in a direct and simple way, incorporating both chronic and short-term changes. The number of data points used can be as large as is appropriate for extracting valid detail from the graph.

Amplitude data are often re-coded into some type of change score, i.e., the data points are not reported as scores, rather the difference between two data points is reported as a score. Simple forms of change scores include difference scores, ratios, and percentage change. They have all been claimed to be inadequate, the reason for rejection being that change scores are almost always a function of baseline conductance level. Therefore, it is claimed, either each change score must be adjusted for baseline or a covariance analysis must be used (cf. Benjamin, 1963, 1967; Lacey and Lacey, 1962; Steinschneider and Lipton, 1965). Edwards and Hill (1967) demonstrate clearly that the procedures used can affect the conclusions drawn from the data. However, if scores are to be adjusted for a covariate, the covariate must be selected as carefully as other data points. The baseline that is most commonly used is frequently not accurate as the covariate, because experimental procedures generate chronic responses that alter the "baseline" (e.g., Folkins et al., 1968). If covariance analysis were to be used, it appears that multiple covariant methods would be needed.

The controversy over methods of statistical analysis is omitted from this paper except insofar as it affects the coding of data. (For a discussion of analysis involving a covariate see Kelley, 1969.) Change scores that are obtained by subtraction (i.e., difference scores) are technically usable with covariance analysis. However, change scores obtained by division (e.g., ratio and percentage-change scores) are already being expressed as a function of "baseline", the baseline being the first of the two data points comprising the score. Covariance analysis would constitute a second correction for base level, i.e., an over-correction. Therefore, if covariance analysis (or any regression adjustment) is going to be used, the researcher must code his data as either absolute
amplitude scores or as simple difference scores. Kelley (1969) presents reasons for concluding that regression adjustments are not valid for skin conductance data, and he also demonstrates that covariance analysis could rarely be appropriate for electrodermal data expressed in any form. It must be concluded, therefore, that the only appropriate codings are absolute amplitude and difference scores.

Difference scores have one principal defect, they completely obliterate from the data all chronic changes. If repeated measures are being taken for each S, the chronic effects may be important. If a response is generated while some effect is still present from an earlier response, then the second response will tend to be of reduced amplitude, although the absolute peak amplitude will tend to be unaffected (Grings and Schell, 1969). Difference scores will therefore be distorted by chronic responses, and the distortion will not be revealed in the scores used. Accordingly, difference scores should not be used unless the sequential responses are clearly independent, i.e., the skin conductance should return fully to the pre-stimulus absolute level prior to the occurrence of the next stimulus. In studies that generate responses that are not clearly independent, the data should be coded in terms of absolute conductance levels so the chronic effects may be evaluated along with the short-term responses.

REFERENCES


During 1971, the trend established over the past few years continued as the use of the polygraph facilities again increased. The Polygraph Section conducted more examinations this year than any other previous year in the history of the Section. There also appears to be an increasing demand for specialization in interrogation, possibly brought about by legislation and court decisions. During the past five years, the volume has increased almost three times.

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<tbody>
<tr>
<td>Examinations</td>
<td>782</td>
<td>830</td>
<td>1144</td>
<td>1389</td>
<td>2094</td>
<td>943</td>
</tr>
</tbody>
</table>

In the year 1971, there were 3,150 examinations scheduled. For reasons generally unknown to this Section, 1,056 of these scheduled examinations were cancelled; several others, though not formally cancelled, did not appear. Some of the known cancellations were due to the fact that persons confessed to investigators after having been scheduled for and sometimes enroute to, a polygraph examination. Whether such a confession can be attributed to the psychological effect of the polygraph is speculative.

In addition to the examinations that were cancelled, seven subjects refused to submit to an examination. These refusals were made after they had entered a polygraph room with an examiner. How many refusals were made in the field in response to an investigator's request is unknown to this Section.

The number of examinations administered by members of this Section during 1971 was 2,094. Inasmuch as some individuals were examined more than once, this figure does not represent the number of individuals but rather the number of separate, distinct examinations. Of this number, 34 were classified as inconclusive.

This classification is attributable to one or more of several causes: lack of intelligence, physical or mental aberrations, use of medications, exhaustive questioning prior to the initial examination, pathological causes, etc.

Twenty examinations were given no classification. There are several reasons why this occurs. Principally, this has been done when the incident cannot be resolved at the time of the original examination. The subject may be asked to return
at a later time for a subsequent examination, and the original
examination will not be classified as either truthful or un-
thruthful. This also occurs when, in the case of possible
dishonest employees, a deception pattern is obtained. This
pattern may result from evasion about something other than the
current issue. If the subject professes complete truthfulness
throughout, the examiner frequently finds it difficult to
separate an association of ideas. For example, if a subject
responds to a question concerning the theft of money but denies
having stolen any, it is extremely difficult to determine if the
response issues from the specific theft under investigation or
theft of money from petty cash, coffee kitty, tools, etc.

The number of examinations classified as truthful was
1,208. It is possible that a subject indicated as truthful
may have been otherwise. Follow-up forms plus conversation
with the concerned investigators have made members aware of
only one such instance. This reading, it was found later, was
produced by a faulty instrument. The instrument has since
been repaired.

There were 832 subjects classified as untruthful. As with
other examinations, investigators do not necessarily make
known to this Section the end results of a case.

From the 832 persons classified as untruthful, after poly-
graph examinations, 268 confessions ensued. This figure
includes confessions to investigators following examinations.

In 180 other examinations, there were pertinent admissions
made, which often enabled investigator to bring a case to its
proper conclusion.

There were 286 crimes cleared. There is reason to believe
that the number of crimes cleared exceeds 286; but again, no
firm liaison is present to substantiate this number. The
figures above do not include 354 examinations of police appli-
cants or 66 examinations made on personnel screening, etc.
Nor do the above figures include any confessions, admissions,
or court actions that may be known only to the investigators.

There were 279 persons examined in regard to homicide cases
during the past year. This figure includes witnesses, suspects,
informants, etc. 135 of the persons examined were classified
untruthful. 46 admitted they were involved in the homicide
either during the examination or following the examination.
15 others gave admissions either linking themselves or someone
else to the crime.
Examinations given embraced literally all types of offenses ranging from malicious mischief to false reports, unlawful sexual intercourse, robbery, and murder. Most investigative units of the Department made use of the polygraph facilities during 1971.

<table>
<thead>
<tr>
<th></th>
<th>CRIME RECAP 1971</th>
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<tbody>
<tr>
<td></td>
<td>HOMICIDE</td>
</tr>
<tr>
<td>JANUARY</td>
<td>49</td>
</tr>
<tr>
<td>FEBRUARY</td>
<td>29</td>
</tr>
<tr>
<td>MARCH</td>
<td>28</td>
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<tr>
<td>APRIL</td>
<td>23</td>
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<tr>
<td>MAY</td>
<td>18</td>
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<tr>
<td>JUNE</td>
<td>20</td>
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<tr>
<td>JULY</td>
<td>20</td>
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<tr>
<td>AUGUST</td>
<td>36</td>
</tr>
<tr>
<td>SEPTEMBER</td>
<td>18</td>
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<tr>
<td>OCTOBER</td>
<td>19</td>
</tr>
<tr>
<td>NOVEMBER</td>
<td>19</td>
</tr>
<tr>
<td>DECEMBER</td>
<td>14</td>
</tr>
<tr>
<td>TOTAL</td>
<td>239</td>
</tr>
</tbody>
</table>
Persons examined were from all walks of life, including victims and alleged victims, witnesses and suspects. Ages of persons ranged from 7 to 80. Fifteen times it was necessary to use an interpreter; and in one case, 5 deaf mutes were examined in an arson case.

Examinations For Other Agencies

Examinations were made by this Section in 1971 for other City agencies as well as other jurisdictions. Such examinations were for:

- Bakersfield Police Department: 2
- Civil Service: 3
- Department of Animal Regulation: 3
- Department of Motor Vehicles: 1
- Downey Police Department: 2
- Federal Bureau of Investigation: 3
- Los Angeles Fire Department Arson Division: 27
- Orange Police Department: 2
- San Fernando Police Department: 1
- UCLA Campus Police: 12
- U. S. Bureau of Narcotics and Dangerous Drugs: 3

Accomplishments - January 1, 1972 to June 30, 1972

During the first six months of 1972, the Polygraph Section has examined a total of 943 persons. The Section has obtained 86 confessions and 93 admissions, a total of 179. We have cleared a total of 138 crimes and have been able to verify an additional 74 charts. The Section has solved, in conjunction with the concerned investigators, 20 homicides. The Section has recovered property in excess of $14,830 and recovered money in excess of $10,671, a total of $25,501.

In addition to the criminal examinations, the Section has been able to directly clear 42 sworn personnel on personnel complaints. 51 other sworn personnel were cleared, indirectly, by examination of the complaintants in personnel cases.

The Polygraph Section examined a total of 161 police applicants on separate issues the background investigators were unable to resolve. In addition, a total of 37 sworn personnel were examined and screened for sensitive positions.

Duties and Responsibilities

Members of the Polygraph Section interrogate suspects in accordance with accepted techniques of police questioning. The
majority of the interrogations are done with the use of a polygraph instrument. It is necessary for the polygraph examiner to become thoroughly familiar with crimes and situations where the polygraph may be used. This is done by visiting crime scenes and by receiving a briefing from the assigned investigators or other personnel assigned to a case. The investigating officers are required to produce the arrest reports, crime reports, photos, arrest records, and any other information pertinent to a particular crime. The subjects to be examined are then interviewed, the test questions formulated, and the examination is administered. The examination and results are then interpreted by the examiner.

In addition to the criminal investigations, the examiner is required to examine police applicants on critical issues that the background investigators are unable to resolve. Departmental personnel are screened for sensitive positions requiring top security. Also sworn personnel and witnesses involved in personnel complaints are tested.

There appears to be an increased demand for specialization in the field of criminal interrogation, which has been brought about by legislation or court decisions. Typical landmark cases would include Miranda, Escobido, Dorado, and others.

Personnel also write reports to explain results of polygraph examinations administered and to maintain other related clerical duties. Personnel are required to attend court trials and Board of Rights Hearings. They are required to prepare documents for court in response to subpoenas and subpoenas duces tectum.

Personnel are required to perform preventative maintenance and to repair minor instrument malfunctions. They are also required to calibrate their individual instruments weekly and maintain the instruments within the department standards.

All trained polygraph examiners are required to assist the Officer-in-Charge in jointly supervising and training the new polygraph examiners assigned to the Polygraph Section. This entails reviewing the test questions and the polygraph charts administered.

**Savings**

There is no way of determining the savings in either man hours or money which accrue through polygraph examinations. Time normally spent by investigators in sifting information is lessened in those instances where a subject has been classified.
as truthful. Conversely, efforts can be concentrated upon those whose polygrams are obviously deceptive. If "Time is Money," considerable savings accrue. An additional factor is the effect upon those truthful individuals who are not necessarily inconvenienced by further investigative efforts viz: arrest or booking.

It has been estimated by the Office of the District Attorney (1964) that each trial day in Los Angeles County (excluding traffic) costs $1000 per day. Most felony trials exceed $1,500. Excluded from this figure are salaries for law enforcement officers, witness fees, expert witnesses, and court appointed attorneys.

It becomes a readily discernible that if the time in court is lessened, a significant savings accrues to the citizens of Los Angeles County, as well as to this Department in that our personnel will spend less time in court.

To the extent that those 448 persons who confessed and/or made pertinent admissions either plead guilty, accepted a lesser charge, or in any other manner lessened the court time, a substantial savings has been realized. An estimate of between $500,000 to $1,000,000 saved in this manner may be reasonable.

It should be noted that persons cleared by polygraph examinations not only saved court time and costs, but also furthered the cause of justice and community relations.

Other items which may be of interested are that:

354 Police Applicants Were Examined
66 Sworn Personnel Screened for Sensitive Positions
145 Persons Were Examined on Personnel Complaints
210 Sworn Personnel Were Examined on Personnel Complaints

Responsibility for arson damage in excess of $89,000 was disclosed.

In excess of $223,490 in stolen property was recovered.

In excess of $13,343 in thefts of money was admitted and much of it recovered.
CRIMINAL LAW CASES 1967-72 INVOLVING USE OR REFERENCE TO THE POLYGRAPH

The following cases have been excerpted from the annual volumes of NEDRUD THE CRIMINAL LAW 1967 through the August issue of the 1972 volume. The abstracts are the copyright of L.E. Publishers, Incorporated, 612 N. Michigan Ave., Chicago, Illinois 60611. They are reproduced here with the permission of the publishers and are not to be reprinted without their express written permission. Editors of NEDRUD THE CRIMINAL LAW are Duane R. Nedrud and Marguerite D. Oberto.

PENNSYLVANIA A concurring opinion observes that the defendant's vehement protestation of innocence prompted the trial court to suggest that the defendant take a lie detector examination with the result that he took the test and passed. "This is one more instance of many that have come into the courts demonstrating the unreliability of the so-called lie detecting machine." If the test results cannot be employed to advance the defendant's innocence, then they should not be used in relation to guilt. In short, the polygraph test is a fanciful notion that should be treated as such." Commonwealth v. Smith, 227 A.2d 653 (3/14/67).

KENTUCKY There is no error in denying evidence of a written offer made by the defendant to submit to a polygraph test. Penn v. Commonwealth, 417 S.W.2d 258 (6/30/67).

MICHIGAN A witness's unresponsive statement in cross-examination that he had changed his testimony when the police give him a polygraph test should have been stricken, when objection was made. And the prosecutor's comment, relating to the arrangements made for the polygraph test for the witness which caused him to change his testimony as being important, also should have been excluded as immaterial upon proper objection. But without an objection and a request for an instruction as to the unreliability of such tests, there is no reversible error which would invoke the inherent power of the appellate court "to prevent fundamental injustice." People v. Baker, 152 N.W.2d 43 (App. 8/1/67).

TEXAS Reference to a lie detector test in the impeachment of a witness was improper. Wall v. State, 417 S.W.2d 59 (6/28/67). WYOMING A witness's testimony that he told the truth after being threatened with a lie detector test (his testimony being changed) was not inadmissible upon the objection that it was improper redict, and the contentsions that it gave, in essence, an opinion as to veracity and that it invaded the prerogative of the jury was not raised until this appeal. No authority is cited to support this contention. Valerio v. State, 429 P.2d 317 (6/23/67).

ILLINOIS Without limiting instructions, the testimony aduced over the objection of the defendant relating to the defendant's taking lie detector tests is reversible error. The court notes that it is not being called upon to enumerate the safeguards under which, if at all, evidence of the fact that a confession followed a lie-detector test may be admitted at a hearing before a judge upon the issue of admissibility of the confession. People v. Triplett, 226 N.E.2d 30 (3/29/67). MICHIGAN Testimony as to the accuracy of the operation of the polygraph, that the defendant had taken a test and that the operator had an opinion, but was prevented by objection from giving that opinion, was prejudicial error where the trial judge did not admonish the jury to disregard the testimony. People v. Frichette, 155 N.W.2d 830 (2/9/68).

INDIANA There was substantial contradiction between the testimony of a police officer and a witness as to the number of photographs shown to the witness for identification purposes and as to the physical characteristics of the persons making up the lineup. The judge, trying the case without a jury, in his findings noted that positive identification was made by the witness and also that an officer testified that a second witness identified the defendant; however, in fact there is no such testimony in the record (the record showing only that the officer said the second witness was asked to identify the defendant, and that the second witness was now out of the city). The contradictions and the infirmities in the State's case when added to the trial court's recent convictions of the defendants present. Admitting a letter requesting a polygraph test for the purpose of sentencing, which test, besides its unreliability, was improperly introduced by an officer who was not shown to be an expert, there was no basis for such a test after the judge had found the defendant guilty, combine to cause reversal of the conviction. Maddix v. State, 235 N.E.2d 475 (4/11/68).

ILLINOIS There is no error in excluding evidence that a defendant offered to take a lie detector test as showing a lack of consciousness of guilt, such offer having no probative value for the reason the accused has nothing to lose by making the officer since if the test is unfavorable it could be inadmissible against him. People v. Durante, 239 N.E.2d 842 (5/29/68). A stipulation having been entered into to take a polygraph examination in the paternity action, the admission of the report of a polygraph examiner was not error where the defendant's objection was neither addressed to the qualifications of the person administering the test nor to the lack of correct foundation. The objections are attempted to be raised for the first time on appeal. The only objection at trial was that the report was a carbon copy rather than the original which the court was informed had become lost. People ex rel. Blackmon v. Brent, 240 N.E.2d 255 (App. 6/20/68).

OKLAHOMA Demurrer to a petition for habeas corpus relief that the petitioner was refused a lie detector test, which test has been held not to have gained that standing and scientific recognition to justify court approval of the results as evidence, is sustained. Further the petitioner wanted only to establish that he was not one of the defendants charged with the murder who actually pulled the trigger. Mullins v. Page, 443 P.2d 773 (7/3/68).

INDIANA Without passing on the admissibility of a polygraph test, such a test like any other scientific evidence can be presented only by the technician testifying before the court with all counsel present. Admitting a letter requesting a polygraph test for the purpose of sentencing, which test, besides its unreliability, was improperly introduced by an officer who was not shown to be an expert, there was no basis for such a test after the judge had found the defendant guilty, combine to cause reversal of the conviction. Maddix v. State, 235 N.E.2d 475 (4/11/68).

Answer by officer that the defendant was asked to and refused to take a polygraph test, which was unresponsive, and there being no indication or claim that the prosecution knew, expected, or solicited the unresponsive answer, is not error. State v. Bowen, 449 P.2d 603 (Ariz. 1/23/69).

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Polygraph test results were admissible upon stipulation where the defendant was represented by competent counsel, the stipulation was explained in reasonable detail and the defendant, not defense counsel or the State, expressed the desire to have the test. The stipulated instruction regarding the test was "sufficiently adhered to." State v. Chambers, 451 F.2d 27 (Ariz. 3/7/69).

The results of polygraph tests are admissible where there has been voluntary consent to the test and to the admission in evidence of the results; but the procedure for asking questions should not include the expression of opinion, which was done in this case, although such would not have been the basis for reversal (reversed on other grounds). "The polygraph examiner properly qualified as an expert should be permitted to explain the nature of the tests given, state the questions asked and answers given, the reactions thereto as indicated by the equipment and his opinion as to defendant's telling the truth when answering the specific questions." (p. 94) The opinion reports the polygraph test instruction given. State v. Galway, 167 N.W.2d 89 (Iowa 4/8/69).

Citing the cases so holding, the court affirms the exclusion of evidence that the defendant had taken a polygraph test and offered to take another administered by a government expert. The defendant's suggestion that, in the ten years since the Tenth Circuit held contrary to his position, the "state of the art" of polygraph testing has improved to the point that the accuracy of such tests equals that of other expert evidence, such as handwriting tests, psychiatric opinion and alcohol blood tests, is rejected because no predicate for the admissibility of the evidence was provided. United States v. Wainwright, 413 F.2d 796 (10th Cir. 6/30/69).

There was no error in denying the motion for results of a lie detector test allegedly given a witness on the claim that it would be used for cross-examination. While not having the report before the court, it is fair to assume that it is "the product of the investigator's selection, interpretations, and interpolations." The test could not be used for impeachment since such test results are not admissible without consent. State v. Schlater, 170 N.W.2d 601 (Iowa 9/5/69).

There is no merit to claimed error because the results of a polygraph test were excluded from evidence where the State, while interposing no objection to administering the lie detector test, strenuously objected to the admission thereof and had not made an express agreement that the results of the test would be admissible. Rawlings v. State, 256 A.2d 704 (Md. App. 9/9/69).

Testimony by officer referring to the defendant's statement she would take a polygraph test only on the advice of counsel is not reversible error where it was inadvertent and defense counsel chose expressly to waive any objection. People v. Tyler, 172 N.W.2d 53 (Mich. App. 8/27/69). See also People v. Brown, 172 N.W.2d 58 (Mich. App. 8/27/69), re no error where just the word "polygraph" was mentioned.

There is no error in excluding evidence that the defendant was willing to take a lie detector test for the purpose of rehabilitating her credibility. State v. Carnegie, 259 A.2d 628 (Conn. 6/3/69), cert. denied, 90 Sup. Ct. 488 (12/15/69).

The agreement by the prosecutor that the defendant would take a lie detector test and pass it, the prosecutor would dismiss the action; but that if he did not pass, the unfavorable result would be admissible in evidence. The prosecutor is bound by this agreement, so that when the defendant passed the test, the prosecutor is precluded from reindicting him. Butler v. State, 228 So.2d 421 (Fla. App. 11/28/69).

While the defendant could have objected to the polygraph test results even under a stipulation that the examiner was qualified and could give his opinion, upon the failure to object when the stipulation was read and the results given no reversal is required. State v. Chavez, 461 P.2d 919 (N.M. App. 11/7/69).

(2) However, the finding of delinquency appears improper where there is no showing of required explanation to the juvenile of his unqualified right to remain silent, even if the minor's parents sought to obtain lie detector testing of the minor. This is true even if it could be assumed the test results in no way affected the finding of delinquency, where such tests are ordinarily inadmissible absent knowing agreement by both sides. In re Collins, 253 N.E.2d 824 (Ohio App. 12/18/69).

The officer's stating that he was a polygraph examiner was not reversible error where there was no objection to the unresponsive answer and no mention of a polygraph examination, the taking of which was the subject of granted motion not to be referred to by any persons testifying in the case. Hart v. State, 447 S.W.2d 947 (Tex. 11/12/69).

The court discusses and rejects the use of polygraph tests as evidence. "[T]he criterion for interpretation of the test chart has not as yet become sufficiently definite to be generally reliable so as to warrant judicial acceptance." (p. 700) People v. Leone, 255 N.E.2d 696 (N.Y. 12/11/69).

Consideration of the fact that a newly discovered witness, claiming he committed the crime, took a polygraph examination is reversible error. Further, the witness should have been brought from the prison to court to determine whether his statement was true. People v. Sinclair, 175 N.W.2d 893 (Mich. App. 2/3/70).

The unresponsive answer by a witness that he had taken a polygraph test is not reversible error where the results thereof had not been given, objection was sustained, the court instructed the jury to disregard the answer, and there is involved a plea of guilty entered before a jury. Renesto v. State, 452 S.W.2d 498 (Tex. 3/25/70).

The mere mention of the warning that the defendant need not take a lie detector test in unresponsive answer to prosecutor's question was not prejudicial where the court properly instructed the jury not to consider it for any purpose and withdrew it from the jurors' consideration. Lee v. State, 455 S.W.2d 316 (Tex. 5/6/70).

(1) The tape-recorded confession established that Miranda warnings were properly given—the court notes that there is no right to be advised of an "immediate" right to appointed counsel. (2) The court finds that if there had been a claim that Miranda warnings were required prior to giving of a lie detector test, it might well have been sustained by the trial court. But the court on appeal will not assume a casual connection between the lie detector test and the subsequent confession, absent any evidence of cause and effect. The lack of timeliness prevented opportunity of prosecution and defense to meet the issue of claim of psychological coercion brought about by the lie detector test. But the warning is given that officers should advise a suspect in custody about his rights prior to any interrogation conducted as part of a lie detector test. People v. Carter, 88 Cal.Rptr. 546 (Cal. App. 5/6/70).

When the defendant testified he offered to take a lie detector test but did not, the door was open to inquire of the defendant why he did not—to show whether the State refused to permit the test or whether the defendant refused and his reason therefor. Williams v. State, 238 So.2d 137 (Fla. App. 7/30/70).

While results of polygraph (lie detector) tests should not be received in evidence over objection and should ordinarily be rejected even if there is no objection, and a
stipulation for admission does not increase the reliability of polygraph results and should not lead to any diversion from the exclusionary policy, the court does not find polygraph tests so demonstrably unreliable as to require a finding of plain error where the results were admitted on the basis of a stipulation. The defense strategy was centered around allowing, not excluding, the polygraph evidence and no objection was made to qualification of the operator nor to admission of the written report. In fact defense counsel stated explicitly that there was no objection to the report. Highly favorable jury instructions were requested and given. This was a clear, intelligent waiver of any privilege to exclude the evidence. Pulakis v. State, 476 P.2d 474 (Alaska 11/9/70).

Polygraph tests being inadmissible as evidence are not subject to pretrial discovery, i.e., the defendant's desire to have the test results of accomplices who were witnesses against him. Anderson v. State, 241 So.2d 390 (Fla. 11/12/70).

The court finds no impropriety in denial of a mistrial motion where the officer in replying to the question of the prosecutor as to whether the defendant said anything after he was arrested said the defendant had requested a lie detector test. Prior to this, out of the presence of the jury, counsel had objected to the prosecution's eliciting this from the arresting officer and the court had sustained the objection; when this was brought out in the presence of the jury, the court again sustained the objection and cautioned the jury to disregard the answer. The officer was again asked if anything was said upon arrest and he replied that the defendant made no comment. Pinkney v. State, 241 So.2d 380 (Fla. 11/25/70).

The court's asking the witness whether he had taken a lie detector test and whether the charge was dismissed thereafter was tantamount to admitting the lie detector test into evidence, which evidence is inadmissible. People v. Andrews, 92 Cal.Rptr. 49 (Cal. App. 12/30/70).

There is no error in precluding the defendant from showing evidence that the police failed to give lie detector tests to prosecution witnesses who were in the store on the day of the killing, results of polygraph tests still being judicially viewed as unreliable. State v. Royster, 273 A.2d 574 (N.J. 2/11/71).

There is no error in denying a motion to be allowed to take a lie detector test as results thereof are not admissible as evidence in this state, Johnson v. State, 248 So.2d 763 (Ala. Crim. App. 5/25/71).

The refusal to take a lie detector test could not be shielded from the judge's mind in making his decision that as an aid to sentencing the defendant take such a test, and it must have had some undetermined influence on the final judgment. The suggestion of the court that the examination should include any unsolved crime in the area compounded the error. The sentences below are vacated and remand is made for resentencing. People v. Ackerman, 269 N.E.2d 737 (Ill. App. 5/17/71). Ackerman, supra, followed in People v. Brown, 269 N.E.2d 735 (Ill. App. 5/17/71).

There is no error in denying the use of polygraph examination evidence at disposition hearing in juvenile delinquency adjudication. People v. Perry, 270 N.E.2d 272 (Ill. App. 3/15/71).

Where the testimony relating to the lie detector was important only as one aspect of the total sequence of events relating to voluntariness of the confession and the result or veracity of the test was not sought to be elicited by the Commonwealth, and where the inference of an unfavorable test result was first brought out by counsel on cross-examination of the officer, the testimony by the officer thereafter brought out by the prosecutor clarifying what the officer had said to the defendant following the test was not prejudicial error. Commonwealth v. Camm, 277 A.2d 325 (Pa. 5/13/71).

Where there had been a stipulation in which the defendant agreed he would submit to a lie detector test and that the examiner's testimony would be admitted on trial, there was no error in the denial of a request that the lie detector examiner's "tape" be produced, which tape was in the possession of the examiner in Chicago, in that the matter sought to be procured is not under the control of the State of Iowa nor the court and is equally available to the defendant. Further, the trial court properly held that the defendant was not entitled to obtain a separate and independent opinion as to the lie detector test. The stipulation limited testimony regarding the test to that of the specific examiner whose qualifications had been carefully investigated and studied. Polygraphic evidence is admissible only by stipulation of the parties. State v. Galloway, 187 N.W.2d 725 (Iowa 6/17/71).

The defendant requested a polygraph test after conviction, asked for a lie detector test and was given one by the police examiner (whose competency the prosecutor admits but no consent to the test had been given because the examiner who performs most of his tests for the Jersey City Police Department in investigations that take place before the arrest or charge. The examiner cleared the defendant. The trial court holds that "after trial, expert testimony based upon a polygraph test examination will be admitted for consideration on behalf of a defendant who voluntarily takes a test, to show facts not decided by the trial jury or material to their deliberations--for example, to show his attitude, obedience to instructions of the court, and disprove accusations that he has not been tried."

However, his ruling is conditioned by accepting from the prosecutor: an opinion of any person who disputes the reliability of the polygraph; a re-examination by another examiner; a polygraph examination of the complaining witness. State v. Watson, 278 A.2d 543 (N.J. Hudson Co. Ct. 6/11/71).

The defendant first injected in the trial the matter of the defendant's being given a lie detector test when he was asked by counsel whether he had offered to take such a test, to which he gave an affirmative answer. The prosecutor then offered, in the presence of the jury, to give the defendant a lie detector test. There is no error when such was brought about by the defendant's own misconduct. The question and the defendant's response may have left the impression that the State had refused to give the defendant such a test. State v. Sluder, 487 P.2d 183 (N.M. App. 6/18/71).

Testimony of the officer relating that the defendant was told the lie detector test indicated he was lying and that the defendant said he could not understand why it indicated he was lying when they asked the questions about the murder of his wife was prejudicial and could not be cured by the court's admonishment to disregard. People v. Schiers, 97 Cal.Rptr. 330 (Cal. App. 8/5/71).

In light of prompt admonition to the jury there was no abuse of discretion in denying a mistrial, where defense counsel had said he did not think anyone knew the results of the lie detector test but that maybe the prosecutor had such and the prosecutor replied that the State would be glad to prove the results of the test to defense counsel and would not want to hide any evidence from defense counsel. White v. State, 280 A.2d 283 (Md. App. 8/13/71).

While reference to refusal to take a lie detector test was improper, it was harmless error considering the overwhelm-
No objection was made as to the question of whether the defendant while not under arrest agreed to take a polygraph test but thereafter the defendant objected "to any reference to the polygraph test." This objection was overruled and the witness was asked if a polygraph test was administered, to which the witness replied in the affirmative; an objection was interposed after the answer was given. The court finds no error as the objection came too late to form the basis for a new trial. The court states there was no evidence before the jury as to the nature of the test, the questions propounded, the answers given or the result of the test. Upon voir dire examination of the officer in the absence of the jury, it was developed by cross-examination that the defendant was informed the test showed he was not telling the truth. "The voir dire examination makes it abundantly clear that the defendant consented to take the test after he signed the written waiver of counsel and of his right to remain silent. There is no merit in this assignment of error." (p. 288) State v. Williams, 184 S.E.2d 282 (N.C. 11/10/71).

The conviction is reversed where the State was permitted to introduce over objection an expert's testimony that a polygraph test showed the defendant to have been lying when he professed innocence of the charge while undergoing the test. This is so although the defendant invited the predicament by first succeeding, over justified objection by the State, in getting before the jury that he offered to take a polygraph test when first arrested and that he had stipulated during the trial to submit to such a test and have the results thereof submitted at the trial. State v. McDavitt, 286 A.2d 86 (N.J. App. 1/11/72).

There is no error in refusing the defendant's request to take a lie detector test concerning the facts surrounding the alleged burglary. State v. O'Connor, 194 N.W.2d 246 (S.D. 2/8/72).

A polygraph-obtained confession is not involuntary. The totality of the circumstances determines voluntariness. The fact that the defendant was a homosexual and that a psychiatrist stated this had a bearing on his confessing because of the "sweet-talk way" it was obtained does not make the confession inadmissible. "If we understand defendants' theory correctly, it is that a statement or confession of a defendant should be considered coerced and thus inadmissible if there are present at the time in the defendant's unconscious or conscious mind factors which create psychological pressures causing him to be willing to give the challenged statement or confession. Such a theory, if adopted, would not only greatly extend the existing legal concepts of improper coercion, but as a practical matter would abort the use of statements or confessions given to the police by a defendant in virtually every criminal case." (p. 753) State v. Keiper, 493 P.2d 750 (Ore. App. 2/10/72).

Reasonable doubt of whether the defendant (concerning death of her adopted child) waived Miranda rights is established by testimony of forensic psychiatrist, the doctor concluding that the defendant was frightened, suggestible, somewhat withdrawn, sad, bewildered, confused, emotionally unstable and perplexed and that the statement given by the defendant in the police-dominated atmosphere (involving use of the polygraph) was coerced by external forces and her internal mental condition and that she could not knowingly and intelligently waive her constitutional rights and could not defend herself against the coercive forces and bring to bear a knowing, intelligent waiver. And further court finds the use of the polygraph coerced a confession from her which was involuntary, the court commenting on the polygraph examiner's interrogation (including his use of a plastic heart to explain the function of the polygraph test), and at the conclusion of the lengthy test the examiner's gathering the graph sheets and leaving the room, telling the defendant he would be able to tell if she had been lying and upon his returning to the room his telling her that it was his opinion she was lying. The examiner told her she was lying two or three or more times. She then made an oral and later a written statement. Prior to taking the test she had read an article given to her by the examiner, the article discussing the possibility of error and that the results could be used in court against her (under certain conditions, including agreement). The court notes she was alone, bewildered, with no one to advise her and that the interview lasted three hours. "In her emotional condition, she was as surely coerced into the confession by the use of the polygraph test as if she had been forced by some other means to give the police officers the statement they were seeking. She had no freedom. For all she knew, the examination could be used against her to show she had been lying. She was not told that such results could not be used against her on trial under any circumstances." (p. 24)


There was competent evidence to sustain the guilty verdict in spite of stipulated evidence involving favorable results of two lie detector tests. Coney v. State, 258 So.2d 497 (Fla. App. 2/29/72).

The confessions give by the relator when he was 15 years of age for murder and robbery for which he is serving a life sentence in state custody are deemed unconstitutional, where the relator was the center of a homicide investigation for eight days and he was isolated from outside assistance, with the court pointing out as most important that there was a long detention without any fixed time or expectation of release and respite from his incommunicado confinement. The technique of interrogation, including the use of a polygraph examiner, was the "relay" method. "The effect of the lie detector as an instrument of coercion was enhanced by Arthur's warning to relator that it would uncover a falsehood. Since the unreliability of lie detectors as a means of discovering the truth is a matter of wide judicial recognition, the examiner's warning amounted to a misrepresentation of scientific fact. Though not tantamount to trickery, the misrepresentation under the circumstances was improper and a factor to be considered in connection with Due Process standards." (p. 34) The court notes that the failure to advise the defendant of his right to remain silent is a significant factor in weighing the voluntariness of his statements. United States ex rel. Monks v. Warden, 339 F.Supp. 30 (D. N.J. 3/6/72).

Since results of lie detector test are inadmissible, the denial of discovery of the results of lie detector test given to the prosecuting witness was not error. The results of the test would neither lead to any additional evidence nor aid the defendant in preparation of his defense. Zupp v. State, 283 N.E.2d 540 (Ind. 6/7/72).

Where the defendant referred to a lie detector test and that the results of the test showed he was not guilty of the offense and that the district attorney had told him that the lie detector test indicated he was not the person who assaulted the prosecutrix, the district attorney could then take the stand and, among other things, testify the defendant did not pass the polygraph test as the defendant "opened the door." Lucas v. State, 479 S.W.2d 314 (Tex. 5/3/72).
Investigation and Preparation of Criminal Cases, Federal and State

By F. Lee Bailey and Henry B. Rothblatt


Reviewed by Norman Ansley


This book is a guide for the trial lawyer defending a criminal case, designed as a step-by-step handbook for case preparation. It has exceptional value in locating expert witnesses and advising counsel on dealing with physical evidence from glass, fabrics, hair, blood, seminal fluids, metals, bullets, powder burns, photographs, and fingerprints. There are whole chapters on preparation of cases on homicide, vehicular homicide, arson, document forgery, narcotics, burglary, and poisoning. There is an excellent topical bibliography, plus a list of recommended technical journals.

"The Use of the Polygraph"

Chapter 14, on the "Use of the Polygraph" (pp. 288-329) has paragraphs on the extent of use, what a polygraph records, the purpose of the test, a description of a three-channel instrument, information the examiner needs, qualifications of a trained and experienced examiner, persons not suitable for testing, the polygraph test, Backster's Polygraph Notepack, judicial acceptance, protecting the client's interest, bargaining with the prosecution (including stipulations on the use of the polygraph), and a summary.

Backster's Polygraph Notepack

The book contains a brief description of Mr. Cleve Backster's "Tri-Zone Polygraph Procedure" and a 24-page example of the notepack as it would be filled in for a theft case. Those examiners who have not been trained by Mr. Backster or are not familiar with his techniques will find this section of the book quite interesting.
Judicial Acceptance

The brief of the testimony on the polygraph given in the case of Peter N. Lazaros v. Michigan is of considerable current value. A 12-page section summarizes the expert testimony of Mr. Lynn P. Marcy, Dr. William Yankee, Mr. Leonard H. Harrelson, and Mr. John E. Reid. Any examiner who expects to testify in court as an expert witness will profit by studying this clear explanation of polygraph instruments, polygraph technique, applied psychology, question formulation, and other technical matters. Then there is the court’s opinion in which the judge admits he is satisfied as to the scientific reliability of the polygraph but declines to admit the polygraph evidence because he believes it should only be done by a higher court. Mr. Bailey successfully defended Mr. Lazaros without the polygraph evidence, so the case did not go to an appellate court. In an argument to the trial court, Mr. Bailey cites a series of precedents and opinions that would be of use in any similar appeal. Included are quotations from Mr. Justice Holmes, Dean Wigmore, Dean Wicker, Professor McCormick, and Professor Richardson.

Text and Reference

The whole book, written in hornbook style, would be an excellent text or supplemental text for a course in investigation. The emphasis is on preparation of a case rather than the law. Thus it is useful to more than defense counsel. As a reference work it has several uses. The style permits you to choose a section relating to a case, such as homicide, and check your work to see if you have covered all the points necessary to develop your case. If you have technical or scientific problems in a case, you may refer to chapters that describe what you may reasonably expect to learn from laboratory analysis or expert opinion. There is excellent advice on interviewing the suspect (client) and witnesses. An attorney will find useful the models for pretrial motions and the preparation necessary for exclusionary hearings. There is immediate reference value in the lists of organizations which can supply expert witnesses, in three dozen fields. Unfortunately, Mr. Bailey did not list the American Polygraph Association as a source of expert witnesses. Nor did he include works on the polygraph in his otherwise useful chapter devoted to a bibliography. The book has an excellent 38-page index and a 1971 pocket supplement of 41 pages. Presumably the work will be kept up to date with annual supplements. The style is clear and easy to read. The book is of value to every investigator and polygraph examiner.

The authors describe a silent answer test (SAT) in which the Subject is instructed to refrain from giving any audible answer to questions during the instrument testing phase. Subject is instructed to listen to the question and to answer truthfully to himself, but silently. The test is given only after a routine chart employing the Reid Control Question Technique. The Subject already knows the questions and their sequence.

The article is based upon 4,000 tests conducted in field cases. The number of hypothetical laboratory cases conducted before introduction into regular case work is not stated. Authors suggest that the SAT causes the guilty Subject to fear being left alone with his thoughts, and causes a conflict when he is told to give a truthful answer, although it is to himself. Also, the authors suggest the guilty Subject is no longer defending himself against the examiner with his verbal denials, and this loss of defense increases his fear of detection. The fear of detection and the conflict about answering truthfully to himself are said to cause the physiological responses. The innocent Subject is not bothered by answering truthfully to himself because it is the same answer he gave during the first test, an answer given out loud.

Advantages are reported to include a reduction in respiratory interference found in the normal preparation to answer in verbal tests; reduction of other talk; and a reduction in effort by the Subject. In addition, it was found that the GSR response became a more valuable indicator, and the whole procedure appeared to have a stimulating effect on subsequent verbal tests.

Physiological measures - breathing amplitude (BA), breathing cycle time (BCT), galvanic skin response (GSR), skin potential response (SPR), systolic blood pressure (BP), oxygen saturation level (O2S), finger volume (FV), and pulse volume (PV) were compared with respect to their relative efficiency in discriminating deception in a lie detection experiment. Thirty Ss were tested. Stimuli consisted of personal words and neutral words made relevant in the context of a mock crime paradigm.

Only GSR, SPR, and FV consistently discriminated better than chance, with GSR and SPR significantly superior to FV. BA and O2S yielded some evidence of discrimination, but were inconsistent across stimulus material. (Author Abstract)


The impressive finding by Sokolov that vessels in the area over the temporal artery constrict in response to painful or threatening stimuli and dilate in response to innocuous stimuli has not to date been replicated. The efforts which have been made, however, differed from Sokolov's experiments with regard to both site and transducer. Sokolov measured from the temporal artery with a volume plethysmograph, while others have chosen the center of the forehead or the area above the eyebrow and used a photoplethysmograph. Location of the transducer seemed, for theoretical reasons, to be the more important variable. In the present experiment therefore a photoplethysmograph placed directly over the temporal artery was used to record both pulse volume and blood volume from a sample of 10 Ss during presentation of tones ranging from 65 to 125 dB. Blood volume responses followed the pattern described by Sokolov: 65 and 95 dB stimuli resulted in dilation, while 125 dB stimuli resulted in constriction.
A biphasic pulse volume response consisting of constriction followed by dilation was also observed, and found to be related to stimulus intensity. The implications of these findings for psychophysiology and for an understanding of the cephalic vasomotor response system are discussed.


Experienced parachutists, when tested during a jump sequence, have shown a reliable early increase in HR, followed by a steady decline; the more pronounced and orderly pattern was related to better overall performance. The conditioned cardiac response, in an aversive conditioning situation, is one of cardiac acceleration, followed by deceleration during the CS-UCS interval. A similar pattern is also found when the UCS is substituted by a signal to respond in a RT task. There is a clear analogy between the observations from real life and the laboratory; is there a relationship between the two? Continuous HR recordings of 30 experienced sport parachutists were obtained throughout 30 trials in a RT situation, which included an incentive to respond quickly; termination of an 8 sec tone served as the cue to respond. The same Ss were also tested throughout a jump sequence, and their performance was evaluated by independent raters. There was a clear relationship between laboratory and real life in (1) cardiac conditionability during the 8 sec anticipatory interval, an orderliness in the inverted V-shaped HR pattern during the jump sequence, and (2) the magnitude of the deceleratory component of the cardiac response averaged over trials, and the amount of continuous decline in HR before the jump. Both measures were directly related to performance. The discussion explores the analogies between laboratory and real life conditioning. (Author abstract)

To distinguish between goal-orientation and the attending activation as causes of acceleration of electrodermal recovery, 16 subjects were examined during task performance and during an activating, non-task condition, cold pressor. Recovery limb time constants (tc) were significantly related to two activation measures, electrodermal frequency (EF) and skin conductance level (SCL). EF, SCL, and change in log conductance were similar for cold pressor and mirror tracing despite significant differences in tc values. Since, in addition, tc decreased with better performance and with increasing task complexity, goal-orientation is considered the primary determinant of acceleration of recovery. There are characteristic individual differences in recovery rate which are relatively stable over 5 consecutive weeks. Rate constant, the reciprocal of tc, has more uniform variance and is preferred for parametric statistical analysis. A warning of shock introduced during a reaction time series caused slowing of recovery. This coupled with slow recovery during cold pressor suggests that enhanced electrodermal activity with retarded recovery may signal a defensive reaction. Descriptors: GSR, electrodermal recovery, performance, defensive reflex, activation.

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**TECHNICAL NOTES**

**Troubleshooting a Stoelting GSR System**  
Courtesy of Stoelting Company

Finger electrodes are the most frequent failure. They can be checked by giving a continuity check with an ohmmeter or similar device, while applying stress along the cord, especially at the point where the finger electrodes and wire are joined.

Pen motor failures are usually caused by caked ink at the bearings. Carelessness with ink and damaged ink wells are at fault. If excessive ink penetrates the movement, there may be a short in the coil itself. Check the component with either of these methods:

a. Disconnect the pen motor from the amplifier section (amphenol connector at the amplifier). The pen motor is free to oscillate when a slight twist and release force is applied with fingers to the pen cradel. A sluggish reacting cradle will indicate either caked ink or a shorted turn in the coil. The coil measures 1000 ohms, is center tapped, and ungrounded. An ohmmeter will verify this. The color code is: #1 green (center tap), #2 black, #3 white. Resistance reading to ground should be "infinite." From green to black and from green to white should read 500 ohms plus or minus 10%. These readings plus a free cradle would indicate a properly functioning pen motor.

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b. An alternate method is to use a 9 volt transistor radio battery which should deflect the pen approximately 2 inches when applied across green and black, and green and white wires. There should be no deflection when applied between ground (physical frame) or any of the three wires. Terminal connections are easily available at the terminal strip mounted on the under side of the galvo panel.

Amplifier check is made after the other checks. Look at all connections. Set sensitivity at its lowest. Allow two minutes for tube warmup. As the amplifier begins to reach warmup, the pen will move slightly away from the median line and return to a stable position on the chart where it remains until the sensitivity control is advanced. A departure of the pen tip from its normal position on the median line (power off) indicates that tube balance is not correctly made or tube aging is occurring. Normal tolerance is plus or minus $\frac{1}{4}$ inches or one division on the chart paper. Allow 15 minutes for the amplifier to stabilize before making adjustments. Adjustment can be made at the slotted control at the rear of the balance or centering control. Allow two minutes to observe any drift which might occur from over or under compensation.

With Auto-Man (AM) switch in manual position, advance sensitivity control to approximately 25%. Pen should fall to bottom of chart. Turn centering control fully clockwise, set AM switch to Auto, and short finger electrodes. Pen should swing to upper limit, pause for 5 to 7 seconds and drift back to median line. This checks the automatic centering and the continuity of electrodes simultaneously. Faulty or intermittent electrodes will cause the pen to react sharply when applying stress to the cord. If the pen does not move up-scale at all, proceed to the next check.

Stoelting models built within the last three years have a spring loaded input connector which provides a simulated "shorted finger electrode" mode. Depressing the top of this connector is the same as breaking contact of shorted finger electrodes in that this connector automatically shorts itself when its mating counterpart is removed. The patch cord from the top panel to the amplifier is not in this test and thus effectively checks the patch cord as good or no-good. A shorted electrode will swing the pen to its upper limits.

If the pen does not respond to the intermittent shorting of the connector at the amplifier, check the electrode fuse located next to the connector. If the fuse is blown, you will see it where spring coil joins the solid lead. If the fuse is good, check for broken wires, burned components, or shorts. Last, a tube check is in order. If these checks fail, your amplifier needs servicing.