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Contents

A Tribute to Fred Inbau

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The First Polygraph

Fred E. Inbau

Generally overlooked in the history of the lie-detector technique is the fact that the so-called "Polygraph" was in existence at least as early as 1906. Its invention, of course, was not for lie detection purposes but rather for use in medical examinations. Nevertheless, it did contain the essential features of the present day instruments and its construction-was based upon precisely the same principles.

The inventor of the first polygraph was Sir James Mackenzie, a famous heart specialist of London, England. He first described the instrument in an article entitled "The Ink Polygraph," which appeared in the June 13, 1908 issue of the *British Medical Journal.*

Following is an exact reproduction of Dr. Mackenzie's article, from Volume 1 (1908), p. 1411, of the *British Medical Journal.*

The Ink Polygraph

"I exhibited at the meeting of the Medical Section of the British Medical Association in Toronto in 1906 a method of recording the movements of the circulation by means of an ink polygraph. I have not hitherto published a description of this method as there has been some difficulty in getting the instrument made, and the maker until lately has not been able to meet the demand for the instrument. "

"A long experience in taking graphic records of the movements of the circulation impressed me with the fact that there were many features in these movements which it was impossible to investigate satisfactorily by the methods in vogue. Changes in the heart's contraction that occurred at infrequent intervals, or in great variety, were apt to be overlooked, while the relationship of the respiration has never been satisfactorily worked out. There was a necessity, therefore, to devise a method by which tracings could be taken over a period of time of considerable duration. I conceived the idea that if a roll of paper could be unwound and levers could be made to inscribe the movements in ink, the end I had in view would be achieved."

"I had considerable difficulties to overcome, but found a skilled helper in Mr. Shaw, who not only comprehended and appreciated my ideas, but constructed an instrument that carried them out. The case, *A*, in the accompanying figure contains the clockwork for the roller which unwinds the roll of paper, *D*, and also the separate clockwork which moves the time-marking pen; *B, B* are the two tambours, and *F, F* their levers, one of which is represented raised, while the pen of the other is resting on the paper. The writing pens are narrow grooved wires, one end fixed to the bottom of a small cistern at the free extremity of the lever. The other end of the grooved wire is adjusted barely to touch the paper. The ink is put into the tiny cistern, and it flows along the grooves to the pen-point by capillary attraction. If the pens are kept clean and the ink is free from dust, they serve their purpose most admirably and are ever ready for use."

"As the radial pulse is the most serviceable of standards, a special method is employed to record it. A splint, *C*, somewhat like that belonging to a Jacquet sphygmograph, is fastened to the wrist in such a manner that the pad of the steel spring falls on the radial artery and is pressed down by an eccentric wheel, *18*, until a suitable movement is transmitted to the spring by the artery; then the broad tambour, *C*, is fitted on to the splint

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The author is Professor of Law at Northwestern University and Managing Director of this publication. Professor Inbau, an authority on lie detection, is the author of Lie Detection and Criminal Interrogation, the third edition of which is now in preparation.

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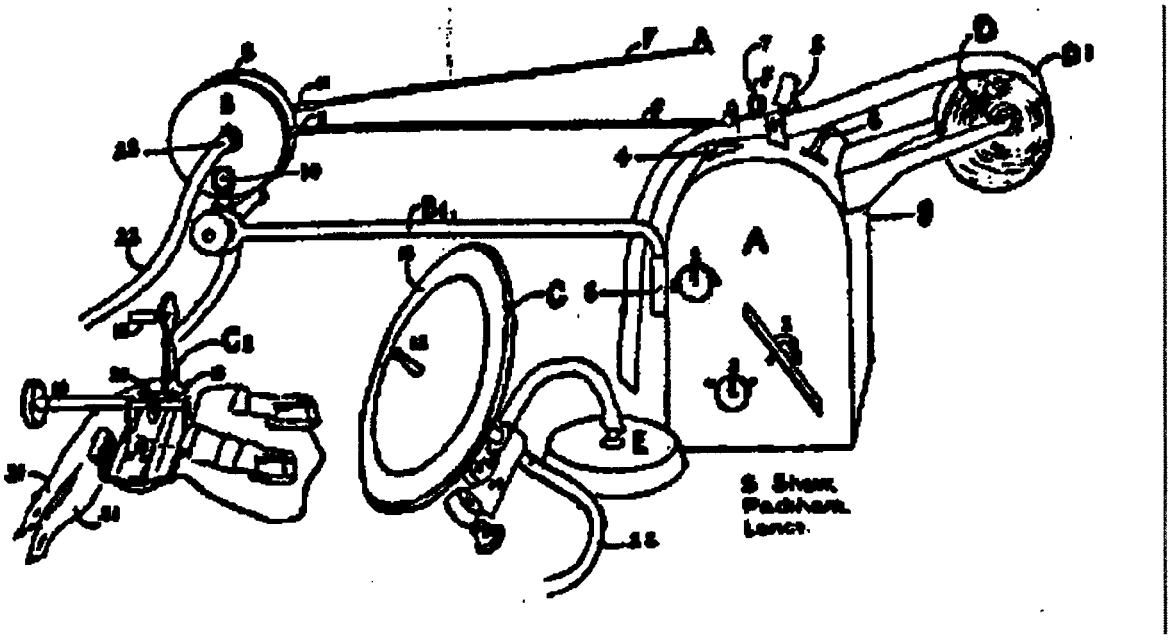

so that the knob, *12*, falls on the moving spring. This wrist tambour is connected to the tambour, *B*, by india-rubber tubing, *22*, *22*, and the movements of the radial pulse are recorded by the lever, *F*. The shallow cup (receiver), *E*, is placed on the pulsation which it is desired to record, and the movement is conveyed to the lever, *P*, of the other tambour. In this way simultaneous with the radial pulse a record can be obtained of the apex-beat, carotid, jugular, or other pulses."

"To record the respiratory movements a bag can be substituted for the receiver, *R*."

"By turning the screw, *3*, the rate at which the paper passes can be quickened or slowed at will. This is of the greatest use, for it often happens that in quickly succeeding events a wider interval may be required, whereas in recording respiratory movements a slow rate is best. As the time-marker registers one-fifth of a second and is driven by a separate clockwork, the rate of the recorded movements can always be ascertained with absolute accuracy."

"It has been suggested that another tambour should be added to record three movements, and I have tried this, but I have practically discarded it, as, though it might be of use occasionally, it would complicate the apparatus unnecessarily. When making observations single-handed the two tambours are quite sufficient to occupy attention. With a little practice this apparatus can be used with the greatest facility. In the course of a few minutes the different movements can be recorded with the patient sitting up or in the recumbent position."

"When the tambour is strapped to the wrist to take the radial pulse, one hand in always free to start the machine and to replenish the ink or regulate the rate, the other hand holding the receiver over the movement to be recorded."

"The instrument is made by Mr. S. Shaw, instrument maker, Padiham, Lancashire."

This interesting historical information about the "Polygraph" came to my attention for the first time while reading an article entitled "The Search for the Truth" by William 0. Gay, in a 1948 number of the *English Police Journal* (vol. 21, No. 4, at page 284), in which Mr. Gay, while discussing the use of lie-detectors in the United States, made the statement that "the Polygraph is really a modification of a device invented by Sir James Mackenzie, the famous heart specialist."

Detection of Deception Technique Admitted as Evidence

Fred E. Inbau†

As the result of an agreement and stipulation entered into between prosecution and defense counsel in a Wisconsin case, *State v. Loniello and Grignano*, Judge Clayton F. Van Pelt of the Circuit Court of Columbia County recently admitted in evidence so-called "lie-detector" records together with expert testimony concerning their interpretation. The instrument which was used in making the tests upon the defendants is known as the Keeler Polygraph,[1] and the witness who conducted the examinations and who explained the records and his interpretation thereof to the jury was Professor Leonarde Keeler of the Scientific Crime Detection Laboratory of Northwestern University School of Law.

This case represents, to the writer's knowledge, the first time in which a court of law has permitted the use of such evidence for the consideration of a jury.[2] Upon several occasions, however, results of this nature had been utilized by judges in civil and minor criminal cases.[3]

At the time when the Polygraph tests were made upon the defendants, Cecil Loniello and Tony Grignano, they were awaiting trials on a charge of assault with intent to murder. Some of the circumstances surrounding the crime in question tended to show that the two defendants were among a party of four individuals at the time when one of their number shot a seriously wounded a sheriff who was attempting to frustrate their escape from the scene of a robbery which the group had committed in a neighboring county. Practically all the state's evidence was of a circumstantial nature. The principal defense consisted of an alibi.

The probative value of all the evidence did not indicate with any degree of predictable certainty whether or not a conviction or acquittal would result. This state of mutual uncertainty seems to have been the impelling motive for so strange and novel an agreement as that entered into between prosecution and defense counsel. The text of this stipulation, dated February 1, 1935, and signed by the parties mentioned therein, is as follows:

Reprinted from the *Journal of the American Institute of Criminal Law and Criminology*, 1935, 26(2), 262-270.

†Instructor of Police Science, Scientific Crime Detection Laboratory, Northwestern University School of Law. Raymond Fellow in Criminal Law, Northwestern University School of Law (1932-1933).

[1] For detailed description of this instrument see Keeler, L., "A Method for Detecting Deception," *1 American Journal of Police Science*, 38 (1930); and Inbau, F., "The Lie-Detector,'" 40 Scientific Monthly, 81 (1935).

[2] Since then, on May 18, 1935, a Chicago physician was permitted to testify, and without any stipulation to that effect, before a jury in a civil case as to deception tests conducted by him upon his client, the defendant in a personal injury damage suit. According to the physician's testimony, his client was not guilty of the alleged acts, but the jury rendered a verdict to the contrary. *Reuter v. Hillberg*, tried in the Circuit Court of Cook County, before Judge John W. Preihs.

[3] In 1924 one of W. H. Marston's assistants testified in two Indiana cases, involving assault and battery for an Indianapolis city court judge as to the results of deception tests conducted in open court upon three defendants. A Tycos, sphygmomanometer was the instrument used for this purpose, and the tests were made on each individual as he testified from the witness stand. According to a personal communication from Dr. Marston, the trial judge's findings accorded with those expressed by the examiner.

Members of the Scientific Crime Detection Laboratory staff have been called upon by trial Judges in several cases, to conduct Polygraph examinations, the results of which were used in arriving at a decision. See report of one such case in *1 American Journal of Police Science*, 381 (1930).

"It is hereby stipulated and agreed by and between the State of Wisconsin, by Arno Miller, District Attorney and H. B. Rogers, Special Prosecutor, and the defendants, Tony Grignano and Cecil Loniello, and Darrell MacIntyre and Gordon Dawson, their attorneys:

"1. That the state shall procure and pay for the services of Mr. Leonarde Keeler to administer the polygraph tests to each of the above named parties, with respect to the charges now pending against them in the Circuit Court for Green Lake County.

2. That the State of Wisconsin and each of the defendants hereby waive any objection which they might have to the admissibility in evidence of the results of such tests and the methods used in the administering of such tests and the experience with respect thereto.

3. That the evidence so taken may be used by either party to be considered by the jury, together with all the evidence in the case against each of such defendants upon the trial of the charges against each of them.

4. That the State shall pay the witness fees for the attendance of Mr. Leonarde Keeler at the trial upon the request of either party.

5. That in addition to the graphs showing the results of such tests, it is expressly agreed that said Leonarde Keeler may testify as an expert as to the conclusions reached by him in the interpretation of such graphs."

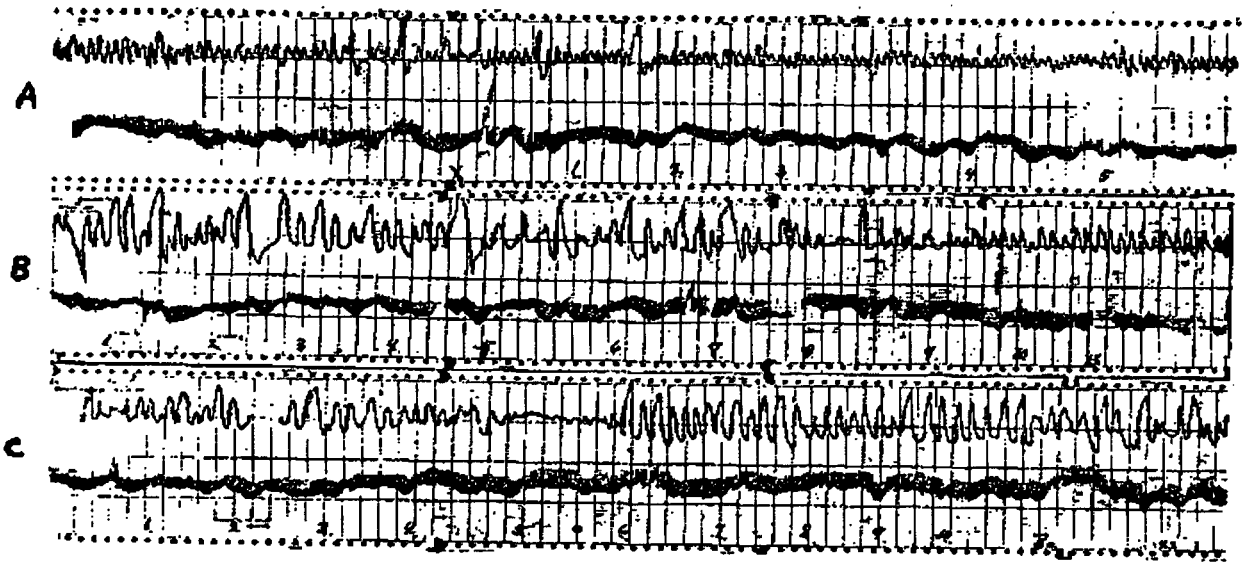

Plate I.

Cecil Loniello's Polygraph records: The upper curve in each record indicates the respiratory changes; the lower curve the pulse wave and changes in blood pressure. On (A) observe the sudden increase in blood pressure at 4, when the subject was asked the question "Did you have anything to do with the robbery in Baraboo?" Similar responses were given on this first test to questions 6 and 7 (not shown on plate), pertaining to the shooting of the sheriff. On (B) observe particularly the general irregularity in the subject's respiratory curve up to and including 8, when he was asked the question "Did Tony Grigano drive the automobile?", and then notice the regularity and uniformity in the breathing from that point on. Also observe the gradual, though irregular, increase in blood pressure up to 8, after which there is a decrease to the subject's "normal. On (C) observe the increase in blood pressure, the change in pulse frequency, and the suppression in respiration at 5, when the subject was asked whether he, Loniello, shot the sheriff. The same question was repeated at 5a. Loniello's average pulse for all tests was approximately 140. At times the pulse rate was as high as 160. (This very rapid pulse accounts for the fact that the pulse wave ink tracings do not show up more clearly on these reduced plates.) The pulse rate at 5 on "C" dropped from 140 to 84 for an interval of 15 seconds.

The following day, February 2nd, each defendant was given a series of Polygraph tests. The results, as interpreted by the examiner, indicated not only a general consciousness of guilt, and deception to pertinent questions of a general nature, but also, to some extent, the particular part played by each defendant in the commission of the crime. The latter statement may seem somewhat paradoxical and cannot be fully appreciated without referring to the accompanying photographs. The Polygrams marked "A" on Plates I and II contain the respiratory, pulse wave, and blood pressure responses to 'various questions pertaining to the shooting and to the robbery. That portion of each record up to the point marked "x" indicates the subject's "normal," during which time no questions were asked. At that point the subject was directed to answer all questions by either "yes" or "no," reserving any explanatory remarks until completion of the test. (Previously, of course, he had been informed of the object and nature of the examination.) On "A" of Plate I, the only pertinent question was asked at (4); (1), (2). (3), and (5) indicate stimulus points of irrelevant question, e. g., Is your name _____?, Do you live in Madison?, Did you have some breakfast this morning?, etc., which were asked for the purpose of further ascertaining the subject's "norm." Similarly on "A" of Plate II, (4) and (6) are points of stimulus with relevant questions; all others being of an irrelevant nature.

The Polygrams marked "B" and "C" contain the responses given during. what might be termed, "name tests," when an attempt was made to ascertain which of ten suspects, including the defendants, drove the automobile and which one shot the sheriff. For the purpose of such an examination, a list containing the names of these individuals, all known to each defendant and some of whom were also alleged to be implicated in the crime, was exhibited to the subjects and at points numbered from one to ten those names were mentioned in the question "Did _____ drive the automobile?" or "Did _____ shoot the sheriff?" "B" on both plates contains the responses to the name test as regards the driving of the automobile, while "C" concerned the shooting of the sheriff.

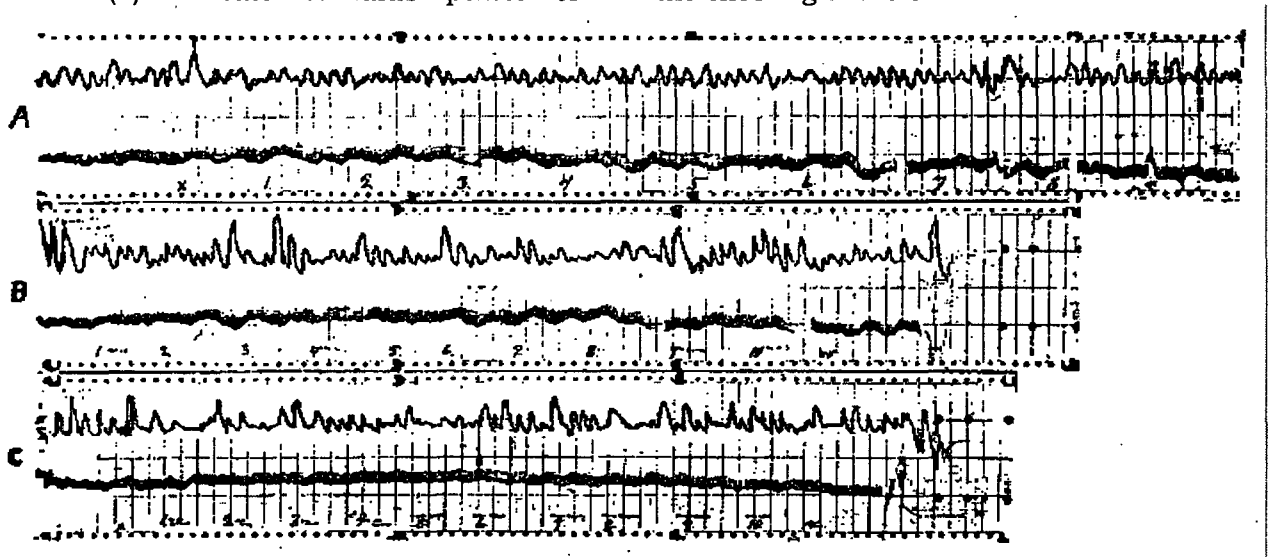

Plate II.

Tony Grignano's Polygraph Records: Observe on (A) the responses to questions 4 and 6: "Did you have anything to do with the drug store robbery in Baraboo?" and "Were you with a group of fellows on the night when the sheriff was shot?" Approximately twelve seconds after the subject replied "no" to both questions his blood pressure decreased rapidly for ten or fifteen seconds, as indicated by the sharp decline in the general curve. On (B) there is shown a gradual increase in blood pressure up to and including 8 ("Did you, Tony Grignano, drive the automobile?"), where the subject had reached his peak of tension, so to speak; then comes a sudden decrease in pressure, followed by a more gradual decrease to a relatively normal condition. In addition to the blood pressure reaction, there appears on the record an indication of suppression in respiration at that point, which is followed by considerable relief (heavier breathing). At 5 on (B) observe the suppression in respiration ("Did Loniello shoot the sheriff?"), and also the "relief" at 6. Grignano's average pulse rate during each test was approximately 120.

By referring to the explanations appearing under each plate, the reader will observe that in Loniello's name test "B" (of Plate I) (pertaining to the driving of the automobile) the greatest change or deviation from his "normal" occurs at (8), where he reaches his "peak of tension" in blood pressure-due doubtless to the anticipation of being asked the question to which he expected to lie--and at which point there occurs a distinct and definite change in his respiratory curve. At (8) Loniello was asked whether Grignano drove the automobile; at (5) whether he, Loniello, drove the automobile, where no change occurred, relatively speaking. From this response at (8) it was, inferred that Grignano drove the automobile. On "C" of Plate I appears Loniello's responses to the name test questions pertaining to the shooting. This time his greatest deviations occur at (5)-"Did you, Loniello, shoot the sheriff ?"-from which fact it was inferred that Loniello shot the sheriff."[4]

The foregoing deductions seem to be borne out by the duplication of these responses in Grignano's name test records, "B" and "C" of Plate II. In "B" Grignano responds to his own name (8) as the driver of the car, and on "C," particularly in the respiratory curve, to Loniello's name (5) as the gunman.

At the trial of the defendants, on February 7th, Judge Van Pelt permitted Mr. Keeler to display to the jury the records pictured on Plates I and II, and also to explain his interpretation, outlined above. Then, for the benefit of the jury and in order to elicit the witness' opinion as to the significance which he thought they should attach to the Poly-grams and his interpretation thereof, Judge Van Pelt propounded the following question which resulted in the dialogue quoted below:

Judge Van Pelt: Would you act upon the results of these tests alone, if they related to the most important affairs of human life?
Mr. Keeler: I don't know just how to answer that question.
Judge Van Pelt: I will state it this way. You have a result in this case, haven't you?
Mr. Keeler: Yes.
Judge Van Pelt: And that result is based upon your detector?
Mr. Keeler: Yes.
Judge Van Pelt: And your experience with the detector?
Mr. Keeler: Yes.
Judge Van Pelt: You have made as a result definite findings?
Mr. Keeler: Yes.
Judge Van Pelt: And would you give those definite findings the standing and the weight to decide the most important affairs of your life?
Mr. Keeler: I wouldn't want to convict a man on the grounds of the records alone. Does that answer the question?
Judge Van Pelt: I think it does. You consider the result, then, an element in the case?
Mr. Keeler: True.
Judge Van Pelt: To be considered with the other circumstances and facts in the case ?
Mr. Keeler: That is right; we do.

The idea expressed in the foregoing opinion found further emphasis in the remarks made by Judge Van Pelt in his charge to the jury:

"Previous to this trial, each defendant submitted himself to examination by the Keeler Polygraph. This examination was conducted by Leonarde Keeler, at Portage, Wisconsin, by a proper stipulation between the State and the defendants, and Mr. Keeler was permitted to tell you the results of the examination in question. This testimony does not tend to show or prove any element of the crime charged. It at most and best only tends to show that at the time of the examination of the defendants they were not telling the truth. Now, Members of the Jury, it is for you to give it such corroboratory weight and effect as you think it fairly and reasonably entitled to receive."

The Jury found both defendants guilty of assault regardless of human. life, in a

[4] Previously it was supposed by the police that another suspect had shot the sheriff.

manner evincing a depraved mind, without any pre-meditated design to effect death.[5] Loniello received a sentence of from one to eight years in the penitentiary, and Grignano one to six. No appeal was taken by either defendant.

Although for many purposes a conviction is tantamount to unquestioned proof of the commission of a crime, the writer realizes the limitations of that principle when applied to the present case. Standing alone, and for the purpose of scientific evaluation, the conviction does not absolutely verify Professor Keeler's interpretation of the defendant's Polygrams--especially in view of the fact that the same interpretation constituted part of the evidence utilized by the jury in arriving at a verdict. Nevertheless, even though considered in light of this limitation, the Polygrams pictured on Plates I and II, as well as the others obtained but not shown herein,[6] offer valuable material for analysis.

In each set of Polygrams may be found a combination and variety of symptomatic changes not ordinarily present in any one individual's Polygrams. For instance, observe Loniello's response to question 5 on "C," consisting of respiratory suppression, sudden increase in blood pressure, and very apparent change in pulse frequency. Also observe the marked difference between that response and the one at 8 on "B." To the trained examiner, however, both are equally indicative of deception. Then, in Grignano's Polygrams can be seen one of his characteristic responses in the nature of a delayed decrease in blood pressure rather than an immediate increase after untruthful answers; his respiratory responses, however, are quite similar to Loniello's, though not so accentuated. To the untrained individual these variations, as well as the responses themselves, may appear quite confusing, but to the experienced examiner, who is in a position to evaluate them on the basis of numerous previous case histories, they are highly significant.[7]

These two sets of Polygraph records illustrate quite clearly the principle that this method is nothing more nor less than a technique--a diagnostic method--for detecting deception.[8] Moreover, they should present, by their obvious complexity, ample proof of the utter folly of an untrained individual considering himself qualified to detect deception merely because he has available an apparatus for recording one or more of these physiological changes. The word "untrained" is here used in a restrictive sense, and by it is meant *untrained in methods of detecting deception.* Whatever other qualifications an individual may possess, and regardless of their nature, it is essential for him to acquire specific training in the technique, either by years of experimentation and study, if working alone and unassisted, or by an extended period of instruction under a qualified examiner, and this too, followed by further experimentation and study.

Just as an aftermath to any new development, incompetent and unscrupulous individuals will appear upon the scene with their "lie-detectors." Already several such persons have made known their presence. They have become possessed of instruments

[5] After the verdict had been received, the Court interrogated the jury as to whether or not the Polygrams as explained by Professor Keeler were of any assistance to them, and if so to what extent. This interrogatory was put to each juror and the response from each was identically the same, viz., that the Polygrams and the testimony were of considerable help to them in determining the credibility of not only the defendants themselves, but also of the other witnesses for the state who contradicted much of the testimony given by the defendants. According to Judge Van Pelt, who informed the writer of the jury's reaction as outlined herein, the jury was of "an exceptionally fine and high type. Among them were two school teachers, and several small business men and farmers—a real cross section of American life."

[6] Five others of Loniello's Polygrams, and seven more of Grignano's.

[7] The term "previous case histories" is here used to include experimental cases conducted under controlled conditions, and also actual cases involving the examination of individuals suspected of crimes ranging from homicide to petty larceny, in which the Polygraph examinations were followed by such convincing substantiating evidence as to leave little or no doubt as to the accuracy of the examiner's interpretation.

[8] See Keeler, L., "Debunking the 'Lie-Detector,'" 25 J. Crim. Law 153 (1934).

recording, in some shape or form, one or more physiological phenomena, and after acquiring a little skill in the mechanical operation they attempt to hold themselves out as "experts." If given the opportunity they will "interpret their results" as best suitable for the particular occasion. Because of this objectionable feature, if for no other reason, it is perhaps highly desirable for courts of law to defer complete judicial recognition of this technique for some time to come, and to restrict its court application to cases such as the present one, in which the stipulation prerequisite will serve as a safeguard and as a deterrent to unethical practices of incompetent examiners. A lawyer, whose client's interests are at stake will in all probability thoroughly investigate the character and qualifications of an examiner before entering into any agreement with opposing counsel to permit him to conduct a deception test and to testify as to his results. This same privilege and opportunity would not be accorded the trial judge who may be confronted with the problem of passing upon the qualifications of such a witness--in the event judicial precedent permitted him to admit testimony of this nature in the absence of a stipulation or agreement.

Every day more genuine interest is being aroused, and more experimentation and investigation is being conducted in the field of detecting deception by conscientious, honest, and otherwise generally qualified individuals. Eventually a sufficient number of them, practicing this art with caution and in a truly scientific spirit, will justify its universal application. In due course of time, after the technique "has gained general acceptance in the particular field in which it belongs,"[9] the judiciary will absorb it just as it has accepted other scientific developments--but not without the same degree of caution.[10]

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[9] See Frye v. United States, 293 Fed. 1013, 1014, 34 A. L. R. 145, 146 (D. C., 1923).

[10] For a discussion of Frye v. United States, *supra* note 9. and State v. Bohner, 210 Wis. 651, 246 N.W. 314 (1933), in which cases the admissibility of "lie-detector" testimony was denied, see Inbau, F., "Scientific Evidence in Criminal Cases: II Methods of Detecting Deception," 24 J. Crim. Law 1140 at pp. 1148-1150. In the Bohner case the defendant had not submitted to any deception test and merely offered, in support of his testimony, to submit to such an examination, which offer was refused by the trial court. As to the effect of the constitutional safeguard against self-incrimination upon "lie-detector" evidence, see *ibid* at pp. 1150-1153.

The Scientific Detection of Crime

Newman F. Baker* and Fred E. Inbau†

The general apathy in this country toward the possibility of detecting crime scientifically may seem discouraging to those from whose minds any such doubts long since have vanished. But this seems to be expected, because mankind usually manifests similar reactions to almost all things novel or out of the ordinary. When men of science suggested the utility of many of our modern inventions, and when medical research made known to the world new discoveries which would lead to the eradication of a disease, there was considerable skepticism. Proposals and theories now recognized as facts of common knowledge have had to force their way through the veil of human understanding. Men had to see the airplane, hear the radio, and read by the light of the incandescent bulb to appreciate even vaguely the meaning of science. What, then, can be expected as a normal reaction to the somewhat novel idea of reliance upon science in the detection of criminal offenders?

Our own country, which has given to the world more than its share of inventions based upon scientific study, has been more backward than European countries in the application of science to criminal investigations. For decades European centers have supported public organizations devoted exclusively to the scientific detection of criminals.[1] European capitals usually possess both a scientific police laboratory and a medico-legal institute. Cases involving matters of a strictly medical nature are allotted to the medico-legal institute; all others, such as those involving fingerprints, firearms identification, document examination, etc., go to the scientific police laboratory. In the United States we find only one well equipped laboratory devoted exclusively to this purpose.

Perhaps the reason for European advancement in the scientific methods of detecting crime is the fact that the police forces of Europe usually are composed of men of the highest intelligence and thorough training, and they appreciate to the fullest extent the value of science as an adjunct to police efficiency. Almost without exception European police officials are doctors of law, science, philosophy, or medicine.[2] It is only natural to expect from these "professional" men a departure from old-fashioned methods of police activities and an adoption of scientific contributions which will facilitate their

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[1]For a detailed description of the European system, see Goddard, Scientific Crime Detection Laboratories in Europe, (1930) *1 Am. J. Police Sci.* 13, 125. Also *Methods and Problems of Medical Education* (9th series, Rockefeller Foundation). Although numerous citations are available for practically every statement in this article, the authors have selected only a few of the most authoritative.

[2]Goddard, Scientific Crime Detection Laboratories in Europe, (1930) *1 Am. J. Police Sci.* 15. See also Fosdick, European Police Systems. It should be noted that public recognition of scientific methods in detection is hampered by the practice followed in the United States of allowing the use of expert testimony by both the prosecution and the defense. As a result we find many so-called "experts" who are willing to pervert scientific data to fit the particular needs of such "experts." This misuse of "science" is not an indictment of scientific methods in general, but it does much to keep alive the skeptical attitude so prevalent among us. The fact that many psychologists are willing to demonstrate home-made "lie-detectors" with exaggerated notions of their utility, has made it necessary for the qualified specialists in this line to avoid court demonstrations of their methods of detecting deception. The testimony of incompetent persons who made the study of firearms a "hobby" delayed the acceptance by courts of the testimony of the highly trained specialists in firearms identification. One individual, a graduate of a school of pharmacy, has set himself up as an "expert" in twenty-three different lines and for the suitable price is willing to testify for either side in a criminal case. This, of course, has resulted in holding back general recognition of the usefulness of science in the detection of crime.

criminal investigations. Unfortunately, a similar concept of police efficiency has not developed in the United States, although we do find a growing consciousness on the part of the police that their work requires the same rigorous training as do other professions.

It is our intention in this article to point out the value of a scientific crime detection laboratory by the use of various illustrations, arranged for convenience in case form, as such problems may present themselves to medico-legal experts. Every case listed is within the realm of possibility, but they are used merely as the basis of the presentation of the technique of the scientist. Many of them represent, either in whole or in part, situations taken from the records of the Scientific Crime Detection Laboratory of Northwestern University, from incidents of privately conducted investigations, or from the case-files of the laboratories of Europe, where most of the methods employed have passed the stage of experimentation and now represent routine police activity. These cases are arranged to show the part played by science in unraveling crimes--*cases impossible to solve by the ordinary standards of criminal investigation.* No attempt is made to explain in detail the methods employed; the idea is only to present situations wherein the services of a trained scientist may be of practical utility. We seek to avoid generalities or predictions, but it is hoped that the possibilities of the field may be made clear by the use of concrete examples.

I

The superintendent of a coal mine was found shot to death. Bullets removed from the corpse constituted the sole material evidence with which the police had to work. A firearms identification expert examined the fatal bullets and found that they were fired from a revolver of German manufacture, and of a particular type and caliber used during the World War. Although this fact in itself proved nothing as to the identity of the murderer, the police investigators were prompted to direct their attention toward a group of foreigners, three of whom had been discharged from the mine because of the dissatisfaction they aroused in fellow workers by advocating certain socialistic doctrines.

A search was made of the apartment occupied by these men, which resulted in the finding of a weapon fitting the description given by the expert who examined the fatal bullets. Test shots were fired from the pistol seized. When observed under a comparison microscope, it was evident from the matching of numerous marks made upon the bullets as they passed through the barrel of the pistol that both the fatal and the test bullets were fired from the same weapon,[3] the one found in the possession of the so-called "radicals."

[3]The mathematical probability of a duplication of the markings on a fatal bullet by those made upon another bullet fired from a different weapon is so remote that it is safe to assume that it is impossible. Osborn gives an interesting example concerning the probability of finding two individuals having eight distinct physical characteristics exactly alike. Applying Newcomb's formula--that the probability of concurrence of all the events is equal to the continued product of the probabilities of all the separate events--even with an extremely small fraction representing how frequently each point may be found, Osborn concludes that the possibility of a duplication is one in thirty-eight trillion and four hundred billion, or something more than thirty thousand times the total population of the earth. Osborn Questioned Documents 2d ed., 226 et seq. The same principle holds true in the science of firearms identification. So, when a fatal bullet contains not eight, but usually a hundred or more individual and characteristic markings, it is reasonably safe to conclude that only a test bullet fired from the same weapon could duplicate these markings. For a detailed explanation of the science of firearms identification see Goddard, Scientific Identification of Firearms and Bullets, (1926) 17 *J. Crim. L. and Criminology*, 254; Churchill, Examination of Fire-arms and Ammunition, (1932) 25 *Trans. Medico-Legal Soc.* 82.

As to the admissibility of "ballistics" testimony in evidence see Wigmore, Identification of Bullet and Firearm, (1931) 25 Ill. L Rev. 692; Serhant, The Admissibility of Ballistics in Evidence, (1931) *2 Am. J. Police Sci.* 202; Buxton, The Science of Ballistics: Judicial Applications, (1931) *2 Am. J. Police Sci.* 211; Baker, The Campbell Case, (1932) *3 Am. J. Police Sci.* 21; (1931) 21 *J. Crim. Law and Criminology* 607; (1931) 29 *Mich. L. Rev.* 513; (1931) 4 *So. Cal. L. Rev.* 311; (1932) 66 *U. S. L Rev.* 190. For an article concerning the difficulties attendant to the introduction of "ballistics" testimony in the trial court, see Wiard, The Cross-Examination of Expert Witnesses, (1931) *2 Am. J. Police Sci.* 538. Firearms identification is now approved by the supreme courts of many states, and numerous citations to such cases may be found in the foregoing articles. The outstanding cases on the subject are: Evans v. Commonwealth, (1929) 230 Ky. 411, 19 S. W. (2d) 1091; People v. Fisher, (1930) 340 Ill. 216, 172 N. E. 743; State v. Campbell, (1931) 213 Ia. 677, 239 N. W. 715.

Fortified with this valuable circumstantial evidence, prosecution was begun against all three of the former employees. The testimony of the firearms expert was introduced together with enlarged photographs showing the striking similarity between the test and fatal bullets. A conviction seemed inevitable as the trial neared its end.

The case occasioned considerable interest in the community with public sentiment favoring the defendants. It seemed to be the consensus of opinion in the vicinity that the accused persons were being prosecuted as radicals rather than as criminals. Few people attached any significance to the unmistakable evidence that the pistol in question was the weapon used in the murder of the mine's superintendent.

However, the defendants were found guilty and sentenced to death. Shortly thereafter defense counsel signified their intention to request a new trial upon the ground of freshly discovered evidence. Meanwhile the presiding judge had received two anonymous letters threatening his life in the event of a refusal to grant another trial. One of the letters was typewritten, the other pen-printed. Nevertheless, the judge denied the application, and the defendants were hanged. But all difficulties did not end with their execution.

Within two weeks of the execution, a suspicious looking package was found in the basement of the judge's home. A maid servant picked it up and removed the string covering, upon which there followed a slight explosion from a bomb. Fortunately, a defect in the mechanism prevented damage other than minor injuries to the servant.

Among the salvaged remains of the bomb were three metal parts--a trigger, consisting of a flat plate of steel, and two rings, evidently cuttings from a small pipe. The nature and construction of the explosive, although home-made, indicated that the guilty party was one skilled in the use of machinery necessary to cut the parts into suitable sizes and, shapes. An investigation was made of the neighborhood wherein resided the most rabid sympathizers and friends of the men found guilty of murdering the mine superintendent. Suspicion fell upon an employee of the mine who had an unusually well equipped workshop in his home. A search of the premises revealed a release mechanism on a gas engine similar to that found on the bomb. This piece of mechanism, together with a flat piece of metal and some small pipes found in the workshop, was taken to a laboratory for metallographic analysis. Through this method a comparison was made under the microscope of the crystalline structure of the bomb trigger and the metal taken from the suspect's workshop. The surfaces of both were polished, and upon the application of a chemical reagent the microscope disclosed not only similar crystalline structure and arrangement, but also a most unique type of crystals seldom found in that particular kind of steel. This, of course, made the situation look even more suspicious. Then again, the rings to which the trigger was attached appeared to be strikingly similar to the pipe found in the workshop.[4]

[4]In a Wisconsin case the testimony of an expert along the lines outlined above played an important part in the prosecution of a bomb-sender. See Mathews, Metallographic Analysis in Crime Detection, (1930) *1 Am. J. Police Sci.* 439. And the use of this evidence was approved by the supreme court of Wisconsin. See Magnuson v. State, (1925) 187 Wis. 122, 203 N. W. 749. Perhaps this is the most remarkable case to be found in the law reports concerning scientific crime detection. Testimony was also admitted to prove that the handwriting on the paper wrapper was that of the defendant; that a round fountain pen had been used--one similar to a pen found in the defendant's possession; that the ink used to address the bomb gave the same chemical reaction as that found in the defendant's fountain pen; that an analysis of the glue used to fasten down the string disclosed the fact that it was of the same kind as that found in the defendant's possession; that the sawdust taken from the defendant's workbench was of white elm--a significant fact because the defendant denied that he had ever worked with elm (a piece of which had been used in the construction of the bomb). Regarding the propriety of the trial court's admission of all this circumstantial evidence the Wisconsin supreme court stated: "The sufficiency of the evidence to sustain the verdict in this case is not challenged. We have, however, set out the evidence with greater particularity than would ordinarily be warranted under such circumstances, because it discloses what may be done by a diligent prosecuting official who has an intelligent comprehension of the things that are necessary to establish guilt in a case of this importance. The guilt of the defendant is as conclusively established as it is possible for it to be. It is scarcely conceivable that any jury could find otherwise than did the jury in this case."

Unquestionably this particular mechanic was in some way connected with the manufacture of the bomb. Nevertheless, the prosecution was reluctant to proceed upon this evidence alone. It then was resolved to obtain specimens or standards of the pen-printing of members of the accused's household, together with samples of the typewriting of a machine belonging to the mechanic's daughter, for the purpose of comparison with the threatening letters received by the judge prior to the execution of the three "radicals." These standards were taken to an expert in document examination. The individual characteristics of the pen-printed threatening letter were identical with the standards obtained from the mechanic's brother who was living in the same house. Although eight similar individual characteristics would render the possibility of a duplication extremely remote, the handwriting expert found considerably more.[5] The standards obtained from the typewriter indicated beyond doubt that the threatening letters were written upon the same machine. Here, too, the expert found distinctive similarities which satisfied the mathematical improbability of a duplication.[6]

The trial of the mechanic and his brother had not proceeded very far when they changed their pleas from not guilty to guilty. They also gratuitously furnished information proving that the previous jury did not err in accepting the "ballistics testimony" in rendering its verdict against the three "radicals."

II

Early one morning the police received a telephone call reporting a murder at a roadhouse located in a sparsely populated section along a country highway. The informant, a professional gambler, was the owner of the establishment. According to his story he and the murdered man were the only ones present after a small crowd of gambling customers had departed; they were standing near a window when the report of a shot was heard outside the home, and immediately thereafter his friend dropped dead with a bullet through his head.

Apparently substantiating the gambler's story was a bullet hole in the window pane. There was nothing about the position of the dead body to discredit the explanation given. Moreover, a pistol containing two discharged cartridges was found along the roadside. There were no fingerprints[7] upon it, and its serial number was defaced by filing, presumably for the purpose of preventing the tracing of ownership to the perpetrator of the deed.

The gambler himself had a revolver in his possession, but obviously not of the caliber which fired the fatal shot. Nevertheless, the police were not convinced of the truthfulness of the story given by their informant, especially since an examination of the surrounding premises failed to reveal any footprints or traces of the mysterious third party involved. This fact induced the investigators to make an effort to determine whether the bullet was fired from the direction pointed out by the witness.

An expert, who had done considerable experimentation as to the effect of missiles piercing glass, was called into the case. He carefully examined the window pane, and

[5]On this point see Lee and Abbey, *Classification and Identification of Handwriting* 40 et seq. Also supra note 3. See Sellers, Science and Advancement in the Examination of Questioned Documents, (1932) *3 Am. J. Police Sci.* 110; Walters, Rex. v. Mike Hack--Handwriting in a Murder Trial in Western Canada, (1932) *3 Am. J. of Police Sci.* 47. Also an interesting article, accompanied by photographs, on the handwriting aspect of the Loeb-Leopold case: Wood, The Loeb-Leopold Case, (1930) *1 Am. J. Police Sci.* 339.

[6]The possibility of a coincidence of scars and deformities is as remote with typewriters as with persons. Osborn, *Questioned Documents* 598 et seq. The mathematical probability of the particular divergences of one typewriter uniting with those of another machine is at best only one in ten billion. *Ibid.*

[7]The science of fingerprint identification is admitted in evidence without much difficulty, owing to the fact of its universal application and acceptance. As to the technical aspect of fingerprints, see Henry, Classification and Uses of Fingerprints, 6th issue of 4th ed.; Wilder and Wentworth, *Personal Identification*, 2d ed. Also see Garson, Finger-Print Evidence, (1906) 3 *Trans. Medico-Legal Soc.* 1.

although consulted only to determine the angle from which the bullet entered the room, he concluded from the nature of the break that the bullet was not fired from *without* but from *within* the very room in which the body lay. The basis for this decision was the discovery that the splintering was not on the inside of the window pane, as would have been the case had the shot been fired from without, but that it was on the outside of the glass.[8] This seemed to be damaging to the suspect's cause in view of his admission that he and the murdered man were the only persons in the room at the time of the shooting.

The discovered pistol was taken to a laboratory where chemicals were applied to the filed surface in an effort to determine its serial number, thereby possibly supplying some information as to its ownership. Shortly after the application of an etching fluid the unknown numbers began to appear[9]--826137. A telegram was sent to the manufacturer requesting a history of the weapon. The reply stated that the owner of the gambling establishment had purchased the weapon directly from the factory about ten years previously.

When confronted with this evidence--one of his own pistols, with two discharged cartridges, and a broken window panet bearing testimony of a bullet being fired from *within* the room admittedly occupied by the two men alone--the gambler confessed to the murder. He admitted that after shooting his companion he fired a second shot through the window pane, placed the body in a position to bear out this carefully planned explanation, wiped his fingerprints from the revolver, then walked to the porch and threw it as far as possible from the road-house and yet close enough to the highway so that it could be found easily, and thereby divert suspicion.

III

While passing through a wooded field on her way home from school, a young girl was seized from behind and a cloth was thrown over her head and face. Then she was brutally assaulted. A short time later a suspect was arrested and identified by the child, but since she had not seen her abductor very well it hardly seemed possible to secure a conviction upon her testimony. Moreover, common knowledge of the unreliability of eye witness testimony even under the best of conditions induced the officials to attach little credibility to the child's identification.[10]

An examination of the scene of the crime revealed a cleverly constructed blind consisting of fir branches and saplings simulating the surrounding growth. The branches had been cut with a large pocket knife apparently the same size as that found upon the suspected individual. This fact alone meant nothing, except as vague and worthless circumstantial evidence. And yet, in this case an expert positively demonstrated that the knife found upon the accused was the one which had been employed to cut the material used in the blind. This identification was made by utilizing the same principles by which it is ascertained whether or not a fatal shell or bullet came from the particular weapon in question. *No two natural or man-made objects are ever precisely the same*--they often may appear to be so, but with the assistance of the

[8]"When the destructive force is applied to a particular area of one of the surfaces of the glass pane (we call it the front one), the glass bends outward because of its elasticity. When the elastic limit is exceeded, it cracks along lines which radiate from the point of application of the force, as a center. These cracks originate on the opposite surface of the glass, for it is here that the greatest tension is produced. The front surface upon which the force is applied is in compression. This situation may be easily illustrated if we bend a sheet of heavy cardboard together--the rear surface cracks." Matwejeff, Criminal Investigation of Broken Window Panes, (1931) *2 Am. J. Police Sci.* 148, I56.

[9]When numbers are stamped upon metal (whether it be on an automobile engine or gun) the underlying surface is also affected. Consequently, when the numbers are filed off, unless all effects of the stamping are removed, there remains a portion of the metal containing vague contour lines of the figures. Although the numbers are made invisible by the filing process, this etching fluid finds its way into the minute crevices and permits discernment of the serial numbers.

[10]See, for example, a recent collection of cases illustrating the danger of relying upon eye-witness identification: Borchard, *Convicting the Innocent.*

microscope they may be shown to be entirely different.

When placed under the microscope the markings made by the knife used to cut the branches corresponded identically with those made upon similar wood cut with the accused's knife. And the possibility of a duplication of the numerous markings by another knife was as remote as in the cases of fired shells, discharged bullets, handwriting, and typewriting.[11] When the blade of a knife is examined under a powerful microscope, the apparently smooth edge appears jagged and rough, resembling the teeth of a saw. Each irregularity in the blade naturally leaves a corresponding impression on the object cut, which impression cannot be duplicated by any other cutting edge. As a result of a demonstration of this fact the jury found the defendant guilty, and upon appeal the admission of this evidence was sustained by the Supreme Court of Washington.[12]

IV

The last time anyone had seen X was when he stopped his automobile to give a ride to a stranger. X was a traveling salesman, and because of his unscheduled itinerary his disappearance was not noticed until some days after he was seen with this unknown person.

Foul play was suspected. The police authorities of neighboring towns and states were given a description of both car and stranger. Some time later one Y was arrested for violating a traffic regulation. At the police station someone suspected him of being the person sought in connection with the unexplained disappearance of X. Both Y and the car seemed to answer the general description.

In an effort to explain his possession of the car, Y produced a bill of sale, actually signed by the missing man, but indicating that perhaps the signature was obtained under duress. Also, there was in the suspect's possession a watch belonging to X. Not satisfied with Y's explanation the authorities held him for further investigation.

After news of Y's arrest was circulated, the police were informed that he was suspected of being involved in four other cases in which the supposed victims were never found. Consequently Y was thought to have employed some ingenious method of disposing of the bodies of his victims.

The suspect was taken to a laboratory where he was tested on a "lie detector"--the Keeler Polygraph.[13] As was expected, his record indicated false answers to questions asked to find out whether or not he had

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[11]Supra notes 3, 6.

[12]State v. Clark. (1930) 156 Wash. 543, 287 Pac. 18. The opinion stated: "Courts are no longer skeptical that, by the aid of scientific appliances, the identity of a person may be established by fingerprints. There is no difference in principle in the utilization of the photomicrograph to determine that the same tool that made one impression is the same instrument that made another impression. The edge of one blade differs as greatly from the edge of another blade as the lines of one human hand differ from the lines of another. *This is a progressive age. The scientific means afforded should be used to apprehend the criminal.*" (1930) 156 Wash. 543, 549, 287 Pac. 18. 20. (Italics added.)

[13]No person is forced to submit to the test, but the impelling motive for willingly submitting is the fear that a refusal may indicate guilt and the confidence in the uselessness and ineffectiveness of the test itself.

This particular "lie-detector" is a mechanical device registering changes in blood pressure and respiration accompanying emotion, by which it is possible to determine whether or not persons undergoing interrogation are replying truthfully. Mr. Leonarde Keeler, who perfected the instrument now known as the Keeler Polygraph, has conducted approximately fourteen thousand tests within the past eleven years. In some seventy-five percent of those cases in which the records indicated guilt full confessions have been secured. The "lie-detector" is used frequently by Chicago banks to detect embezzling among employees. In one instance a bank desired to detect the embezzler of a sum of five thousand dollars. Tests were run upon all fifty-six employees but, instead of finding one liar in the group, twelve were discovered. Of the twelve, nine confessed to embezzlements hitherto unknown to the bank officials. For a detailed description of the "lie-detector," and a discussion of the physiological principles involved, see Keeler, A Method of Detecting Deception, (1930) *1 Am. J. Police Sci.* 38. See also McCormick, Deception Tests and the Law of Evidence, (1927) 15 *Cal. L. Rev.* 484, (1931) *2 Am. J. Police Sci.* 388.

A "lie-detector" must record two or more bodily changes, for no one change can be depended upon to give true and significant responses to deception. The psycho-galvanic reflex is a valuable indicator in some cases. It indicates the change

murdered the missing man. But the important problem was to find the body, since the first step in criminal prosecution in homicide cases is the proof of death. He was asked whether his victims were poisoned. shot, drowned, etc. A specific response was recorded as to shooting. (Incidentally, a pistol was found under the seat of his car.) Then he was questioned as to the method of disposing of the bodies. "Did you burn them?" "Did you bury them?" Numerous questions of this type were asked, to only one of which the suspect responded in a guilty fashion. He had buried the bodies. But where? Where was the body of X? After numerous questions to that effect, such as "near the river," "by the railroad," "in a cemetery," Y responded specifically to "cemetery." The next inquiries were directed toward the exact location. A map of three states in which Y might have disposed of the body was shown to him. His record indicated a false response as to one of these. Attention was directed then to that particular state. A larger map was procured, and divided into ten sections of the state. By a similar process nine sections were eliminated. Finally, the possible area was narrowed down to one and one-half square miles, within which were two small cemeteries. At this point of the investigation Y became so incensed that he jerked away the equipment and proceeded to pound upon the machine with his fists, rendering it unserviceable.

A careful examination was made of the burial grounds. One grave in particular gave evidence of tampering. After digging therein a short time, the body of X was unearthed about three feet beneath the surface. The modus operandi in disposing of the victims of this particular criminal was to take the body to a cemetery in which there had been a recent burial. He would dig into the freshly disturbed mud and there place the lifeless body of his victim. In this clever manner Y thought he had completely disposed of the corpus delicti; and were it not for the "lie-detector"' the body might never have been discovered.

V

One cold wintry day, after heavy rainfall, an inhabitant of a small town departed from his home for an afternoon's hunt in nearby fields. The next morning his dead body was found riddled with buckshot. Some few yards away from the place where the body lay was a fired shell and also footprints, apparently those of the person who fired the fatal shot. The footprints led to a muddy road, at which place began the tire tracks of an automobile. Appearances indicated that the murderer escaped from the scene in a vehicle which left the tracks imbedded in the mud.

Because of the paucity of any further clues it seemed highly desirable to preserve the perishable evidence of the footprints and tire tracks. An expert skilled in the technique of "Moulage" (a method of making casts)[14] was employed to make permanent impressions of both footprints and tire tracks by this process of trace fixation. In the resulting casts there were preserved even the most minute details such as the number of nails in the shoes and the small holes and cuts in the automobile tires. Consulting available data it was determined what type, size. and make of tires were used on the automobile in which the murderer escaped.

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in skin resistance to electric current, which is an extremely sensitive criterion for changes in an individual's emotional state, but it cannot be relied upon alone. The blood pressure, pulse and respiration are indispensable responses in order to get a reliable cross-section of psycho-physical reactions. A record of the combination of all these bodily variations is most desirable for detecting deception.

It must be remembered that the successful use of any such device depends largely upon the skill of the operator in selecting the questions propounded and correlating the emotional responses. This is something an untrained "psychologist" cannot do!

[14]See Watzek, Searching for and Recording Circumstantial Evidence, (1930) *1 Am. J. Police Sci.* 272. Also, Goddefroy, A Process of "Moulage for Reproducing Marks Indicative of Forcible Entry and Molding Those Left by Tools. (1932) *3 Am. J. Police Sci.* 42.

There was only one person in the community who had any noticeable dislike for the murdered man. Suspicion fell upon him. When questioned, he denied any knowledge of the unfortunate event. But the tires of his automobile checked as to the size and make of those from which the "Moulage" casts were made.[15] The suspect was held for further investigation. Then it was found that the prints of his shoes were similar to the footprints at the scene of the crime. But the suspect denied even using his gun recently. Here again a fallacy was detected; an expert in the use of firearms positively determined that the gun had been fired only a short time previously, and judging from a few unburned grains of powder lodged in the barrel he ascertained that it was of the same kind as that used in the fatal shell. Yet there was a more certain and definite test. A cartridge was fired from the gun belonging to the suspect. Examined under a microscope, the marks left by the firing pin and the breach face of the gun upon the head of a comparison shell were identical with those found upon the fatal shell itself. The possibility of another firing pin or another breach face leaving the same number and kind of markings was infinitely remote.[16]

Ordinarily, proof of the fatal shot being fired from the accused's weapon would not constitute sufficient evidence to sustain a conviction, because such testimony does not place the gun into the hands of the suspect. But in the instant case the preserved footprints and tire tracks constituted sufficient circumstantial evidence for the jury to render a verdict against the accused for murder in the first degree.

VI

One night the report of a pistol shot was heard from the kitchen of a dwelling house. The occupant was found dead, and there was no indication of suicide. Upon investigation by the police they found none of the conventional traces of a criminal who came to commit burglary and killed when taken by surprise. The mute evidence remaining was an apple bearing teeth marks, apparently made by the person who had stalked about the kitchen after entering through its window.[17] By examining the teeth impressions upon the apple, it was determined that the teeth were wide apart, and that two of the upper set, one incisor and a canine, were broken at the edges. This eliminated the deceased as the person who bit into the apple, because almost all of his teeth in the upper jaw were false and unbroken. A number of suspects were apprehended, and one of them was arrested upon the basis of the similarity of his teeth with the markings found upon the apple. (Researchers have indicated that teeth are distinctive in much the same way as are fingerprints.)

Obviously the apple would not remain as evidence until the time of the trial of the suspected murderer who, of course, could be expected to secure continuances. Here, again, science came to the aid of the criminal investigator. A "Moulage" Cast was made of the teeth impressions. And it played an important part in the circumstantial evidence which finally brought about the criminal's conviction.

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[15]See Chavigny, Tracks of Vehicles, (1930) *1 Am. J. Police Sci.* 156, for a discussion of tire prints in general. For an example of such a case in which tire prints played an important role in a criminal prosecution in Pennsylvania, see Paessler, The Cessero Case, (1930) *1 Am. J. Police Sci.* 193.

[16]Supra, notes 3, 6. as to the mathematical probability of a duplication. The firing pin is that part of the mechanism which on the pull of the trigger strikes the shell, causing the explosion. Because of the machining operations it undergoes in the course of manufacture it acquires characteristic markings which are impressed upon the center of the shell. The breach face markings are made when the empty shell is hurled violently back against the breach face as a result of the recoil. These are characteristic and distinctive of that particular gun and no other, just as much as finger-prints vary with each person. See Mezger, Heess, and Hasslacher, Determination of the Type of Pistol Employed from an Examination of Fired Bullets and Shells, 89 Archiv. fur Kriminologie 1, 93; (1931) *2 Am. J. Police Sci.* 473, (1932) *3 Am. J. Police Sci.* 124.

[17]This may seem strange--eating food when the mission is to steal--but it is a common occurrence.

Today the permanent record of the same teeth impressions--the "Moulage" cast--adorns the prosecutor's desk, long after the apple itself has become a disintegrated mass.

VII

In another homicide case the only clue to the possible identity of the murderer was a bloody coat found a short distance from the scene of the crime. The victim was a stranger in the community. Before burial, however, a "Moulage" cast was made of his face, thereby leaving with the police a permanent means of subsequent identification long after the interment of the body. (And true enough the victim- was identified in this manner.)

Although some inference could be drawn as to the size and weight of the owner of the coat, it seemed to yield no further information. On the inside lining of one of the sleeves, however, there was a faint trace of a laundry mark. The numbers were not discernible to the naked eye, nor was a magnifying glass of any help. At the particular laboratory to which the coat was taken, the lining of the sleeve was placed under ultra-violet rays, artificially produced by means of a mercury vapor arc lamp.[18] And as though some unseen hand was at work, the fluorescence given off by the ink which had been absorbed deeply within the cloth disclosed three letters and two numbers--"F. E. W. 26." A check-up on the laundry records of the community traced the ownership of the coat to a person whose name corresponded with the initials.

After being arrested the suspect admitted that the coat belonged to him but denied that the blood was of human origin. According to his explanation, as is usually the case, it was the blood from an animal--this time the blood of a rabbit which had been shot and carried over his shoulder. Not wishing to soil his car he "hung the rabbit on the door handle and threw the old coat away at the point where found." This explanation seemed plausible, in view of the fact that blood was found only upon the back of the coat. Moreover, the suspect had been hunting rabbits about the time stated. Perhaps this coherent story might have won his freedom, were it not for the result of a serological test proving the blood to be that of a human being and not that of an animal.[19]

While in the county jail, the owner of the bloody coat requested the privilege of communicating with a friend of his, known to, the police as a dangerous character. The accused was not anxious for a personal interview, but preferred to write a letter. Although there appeared to be something queer about his choice, since this particular friend lived but a short distance away in the same city, the request was granted. The letter itself contained nothing more than a short paragraph requesting a friend to obtain a lawyer for the accused. Still suspicious about this peculiar arrangement, the keeper consulted the same expert who had unveiled the laundry numbers which led to the arrest, and was informed that possibly the letter contained some invisible means of communication. To test this theory the letter was placed under ultra-violet rays in the same manner as in the case of the lining of the bloody coat sleeve. To the utter amazement of the keeper and other on-lookers; the following message came into view between the visible lines: "You helped me get into this mess, now help me out of it. At one thirty tonight bring tools near my cell and whistle twice." In writing this message an ordinary stick pin had

[18]For detailed information as regards the application of ultra-violet light to the detecting of crime, see Pacini, The Ultra-Violet Detective, (1930) *1 Am. J. Police Sci.* 237: Goodman, Medico-legal Uses of Filtered Ultra-Violet or Black Light, (1930) *1 Am. J. Police Sci.* 260.

[19]The serological or precipitin test is based upon the fact that when an animal, usually a rabbit, is injected with defibrinated blood, (i.e., the serous or clear part of the blood) of an unrelated animal (e.g., a human being) an antiserum is produced in the rabbit's blood. This antiserum will precipitate the serum of the animal whose blood was injected. The precipitins are specific, that is, they precipitate only to the serum of the same species against which the rabbit has been immunized, and the tests may be made of very old blood stains; in one recorded case, after fourteen and one-half years. See Webster, *Legal Medicine and Toxicology* 178; Glaister, Some Results of Recent Medico-Legal Research in the Examination of Blood-Stains and Hairs, (1928) *1 Police Journal 62.*

been used with urine as the writing fluid.[20] This was a rather effective procedure, for all a recipient needed to do in order to bring out the invisible message was to place a hot flat iron upon the paper. Of course, the police authorities could have done likewise, but by the use of the ultra-violet rays there was no marring of the letter itself. The message was delivered to the unsuspecting party, the police retaining a photograph of the secret writing as disclosed under the ultra-violet, and preparations were made for the capture of another guilty participant in the principal crime as well as in the attempted jail break.

At the appointed hour the recipient of the secret message appeared near the jail house and whistled twice. A guard, armed with a shotgun, ordered him to surrender. What transpired thereafter only the guard and another member of the police force knew. According to their stories the man attempted to get away, stopped after having run about twenty feet and then turned around to shoot with his pistol, whereupon the guard fired upon him with the shotgun. The man died immediately.

The prosecuting attorney regretted the death of this accomplice, thinking that his presence as a co-defendant would have simplified matters. This, coupled with the fact that the police superintendent doubted the guard's story about the necessity for the shooting, prompted an investigation to determine the distance at which the gun was fired from the place where the deceased stood. It appeared that the guard fired from a distance much shorter than that which he stated. An expert in the use of firearms fired the guard's gun at various distances to determine the extent to which the shots scattered when they struck the large sheet of paper placed at distances of five, ten, fifteen, twenty, and twenty-five feet. These patterns, which disclosed the extent of the scattering of the shots, were compared with the pattern upon the body of the accomplice, and in this way it was ascertained definitely that the man was shot at a distance of not less than twenty feet, thus confirming the statement of the guard.

VIII

One cold windy night, fire broke out in a home located in an exclusive residential district of a suburb adjoining one of the country's largest cities. The flames enveloped this once beautiful structure in a relatively short time, and before the arrival of fire engines it was completely destroyed. Two adjacent buildings were badly damaged. No one was home at the time the fire started, and consequently no explanation was obtainable as to its origin.

A member of the fire investigation bureau proceeded to investigate the premises the following morning. Accompanying him was a representative of the insurance company which had issued a policy covering the loss. The rapidity with which the fire spread, the recent depreciation in property values, and the fact that only a short time before the owner of the building had incurred severe financial reverses, when considered together, suggested the possibility of arson. In fact, a cursory examination prompted another of a more thorough nature.

Although the house had been burned almost to its foundation, the investigators discovered that under the remains of each bed there was a considerable amount of short pieces of charred wood and ashes apparently different from the charred wood and ashes which remained from the burned floors. Without disturbing the arrangement, plans and sketches[21] were made of the premises and

[20]Lemon juice, milk, and starch water are a few of the easily accessible fluids which may be used as a meant of invisible communication. For a list of the numerous possible methods see Kytka, Description of Methods by Which Secret Communications May Be Prepared--and of the Procedure Employed to Render them Visible, (1930) *1 Am. J. Police Sci.* 326.

[21]As to the importance of making diagrams, etc., of the scene of the crime, see Gross, *Criminal Investigation*; Hutchinson, Plans and Sketches; 1 Shore, Crime and Its Detection 183.

its contents, and photographs were taken of the materials and surroundings under each bed.[22] Then samples were secured of the burned material, which appeared to have served the purpose of kindling wood, also parts of the flooring both under the bed and some distance away. These specimens were taken to a laboratory containing proper equipment for conducting a microscopic examination.

Within less than a week after the fire the insurance company denied liability for the loss. Moreover, the police authorities prepared to instigate proceedings against the owner of the building for violating a statute making it a crime to set fire to buildings with the purpose of defrauding an insurance company. And it was upon the following evidence that the prosecution was begun and successfully carried on: from all indications it appeared that the fire had originated under the beds; and moreover, the cross checks on the burned flooring at those places indicated that some material had burned there with a hotter flame than is produced by the burning of normal wood.[23] It was certain from the results of microscopic examinations that the short pieces of charred wood under the bed were of pine, whereas the floor boards of the house were of cypress, and the beds of birch.[24] Probably the most valuable evidence, and that which impressed the jury most of all, was that indicating that kerosene had been used upon the wood kindling and also upon the floor board area under the beds.[25]

IX

The body of a young girl was found by the side of a lonely road. She had been strangled to death, and there was evidence of rape. Apparently her body had been thrown from an automobile. Not the slightest material clue remained as to the identity of the criminal. The girl herself was identified; the approximate path she traversed on the day of her death was known--but nothing more.

An investigator proficient in the use of a microscope, and possessing adequate knowledge and data concerning the structure and chemical composition of soil, vegetable matter, particles of dust and such other substances, was called upon to furnish a possible clue. Working carefully he took samples of scrapings from the soles of the shoes worn by the victim.[26] The dust from the clothing was removed very cautiously by beating it into a large paper bag. Upon returning to his laboratory, this microscopist, whose methods had been scoffed at by persons

[22]Photographs of evidence prove invaluable to the prosecution's cause in numerous cases. An enlarged photograph is far more impressive to the jury than the best verbal description given by an expert witness, regardless of his capability. Especially is this true in matching the markings left by rifle barrels upon fatal and test bullets, or in matching the impressions made upon fatal and test shells by the firing pin or breech face, and in the comparison of handwritten or typewritten questioned documents with the genuine specimens.

[23]When wood burns normally, the cross-checks on the charcoal have a definite size, but the checks are finer and closer together if some material is present that burns with a hotter flame than wood.

[24]The differentiation between charcoals from different kinds of wood depends upon the presence of perforations in the wood, the size and proximity of which are characteristic for wood from various species of trees. For instance, birch charcoal shows series of minute perforations very near to each other, while pine charcoal has large perforations much wider apart. Mitchell, *Science and the Detective*, 1 Shore, Crime and Its Detection 78.

[25]Every combustive liquid leaves its own telltale mark on the wood. For example, if turpentine is burned on pine, the photomicrograph shows long rough ridges with cross cracks. If it was linseed oil, the ridges are higher and more uniform. A rough plane without cross cracks indicates that alcohol was used. If the plane is smoother, but with cracks, kerosene was employed, and if the plane is smooth with large cracks, then gasoline was the agent that carried the fire. Wolfe, Fire Detectives Make Ashes Talk, (1932) *56 Popular Mechanics* 917.

[26]In this connection see Gross, Criminal Investigation 144; Locard, Dust and Its Analysis, (1928) *1 Police Journal* 177; Schatz and Saale, Dirt Scraped from Shoes, as a Means of Identification of Dust Traces, (1930) *1 Am. J. Police Sci.* 55; Locard, the Analysis of Dust Traces, (1930) *1 Am. J. Police Sci.* 276, 401, 496. Especially note pp. 496 et seq., containing a group of twenty-two actual cases in Europe where the criminals were detected by knowledge obtained from analyses of dust traces. See also Mitchell, Circumstantial Evidence from Hairs and Fibres, (1930) *1 Am. J. Police Sci.* 594.

who witnessed this procedure, prepared slides of the specimens obtained, and then studied them under the microscope. In both instances he was able to determine the presence of slaked lime, which is sometimes used as fertilizer, grains of oats, and small particles of straw. What did this indicate? That very likely the girl had been in a farm barn recently, and presumably at the time she was ravished. Not only did the microscopic examination reveal this, but it also pointed out the particular barn. After searching the various farm buildings of the vicinity, one was found in which there was a supply of slaked lime, scattered grains of oats, and straw. This happened to be the only farm in the community upon which slaked lime was used for fertilizing purposes. The farmer, his family, and the farm hands were questioned. But, of all these persons the police were looking for a particular one who should have a scratch upon either neck or face. Why? Because a microscopical and chemical analysis of the fingernail scrapings taken from the deceased revealed the presence of skin and blood cells. Much to the surprise of many persons present, a farm hand's face had a large scratch upon it, running from the eye down to the lip. He explained its presence there as being the result of an encounter with a piece of wood in the dark the night before. The situation began to look suspicious, and a further search was made of the clothing worn by this particular individual. His garments worn the previous night were examined to see if they bore stains of seminal fluid. To determine this, the stained portions were placed under filtered ultra-violet light, where they fluoresced with a lavender color characteristic of the chemical composition of seminal fluid. The area involved was marked off, and bits of material were cut out for microscopical study, which revealed the presence of individual spermatozoa. When the investigation reached this point it came to an end, for the suspect broke down and confessed that he had committed the crime.

X

A young girl was found choked to death. Medical examination disclosed the fact that her murderer had forced two fingers down her throat and compressed the larynx until suffocation resulted. There was no evidence other than this, with the exception of a few strands of hair between the victim's fingers. The hair was taken to a scientific crime detection laboratory where a microscopic examination revealed certain peculiarities latent to the naked eye.

As a result of the study of the hair by a microscopist who had devoted considerable time to research along these lines, an approximation was made as to the age of the murderer.[27] Moreover, the expert was able to say that the hair came from a brunette who was approaching baldness. This further fact induced the police to search for a rather elderly individual--at least one with hair fitting this description.

Equipped with this information the police apprehended one of the victim's friends, the least suspected of the lot, because of his advanced maturity over the girl's other suitors. Nevertheless, he fitted the description in every respect. After his arrest a sample was taken of his fingernail scrapings. Upon microscopical examination they were found to contain epithelial cells and human blood corpuscles. Chemical tests further confirmed the presence of blood.

[27]The principle upon which this new method of identification is founded is the number of tiny rings on a single shaft of hair. In growing, rings are formed upon the hair shaft at right angles to its long axis, and by counting these rings it is possible to approximate a person's age. For instance, in the case of a young person the rings are far apart. In the hair of an old person they are found much closer together. A comparison with records of known hair samples enables a qualified expert to determine age fairly definitely. E. Carleton Hood, of the Scientific Crime Detection Laboratory of Northwestern University, is accredited with having discovered this method of identification in 1931, after nine months of research. As to the importance of hair in criminal investigation see Grose, Criminal Investigation 131 et seq. Often the position of hair fibres in the clutched hand of a victim will indicate whether or not they were placed there as a plant rather than having been extracted from the head of an assailant. See also, Glaister, Some Results of Recent Medico-Legal Research in the Examination of Blood Stains and Hairs, (1928) *1 Police Journal* 62.

Undoubtedly the presence of the tissue and blood under his fingernails would have required considerable explanation before he could sustain an alibi, but the accused was spared this difficulty when he committed suicide while awaiting trial.

XI

One Sunday morning the police received a telephone call from a woman stating that her husband had committed suicide in their bedroom. The police found the body with a pistol in one hand and a bullet wound through the head. But the body was cold already. In fact, rigor mortis had set in, which indicated that death had occurred before the time stated by the wife of this man.[28] That fact provoked further investigation. A man identified as the wife's paramour was questioned, but he denied having any knowledge of the affair. He seemed so convinced of his innocence that he consented to a scopolamine (truth serum) test.[29]

While under the influence of this drug, which had been administered by a subcutaneous injection, the subject was asked "what he did with the pistol after the killing." To this question he replied: "I threw it into the river." As to the disposition of the body he stated that he covered it with branches. At this point the interrogators were in a quandary because obviously nothing like this could have taken place in the instant case. For that reason the questions were repeated. The subject then answered that he "hid the gun in a house and threw the body into a river in Ontario." *He also gave the name of the victim.* After further questioning the man stated that the woman in the instant shot her husband, but that he did nothing more than strike the husband with his fist. Evidently the suspect was giving *more information* than he expected to give, and certainly *more* than the officers had counted on receiving.

When the subject regained consciousness, he was told that he had implicated himself and that he should sign a written confession to that effect. But he merely laughed at the experts, being firmly convinced that the test was worthless. Then he was reminded of the time when he threw a pistol into a river, and "covered the body with branches." Upon hearing this, the man's face paled. He was reminded of the "murder in Ontario." Then came the climax. He slumped in his chair and made a complete confession. He told how the husband in the instant case arrived home and found him there as an unwelcome guest. There was a struggle with the husband; the wife ran for a pistol and placed it close to the husband's head and fired, without her paramour knowing of her intentions.

As to this particular crime the man apparently was guilty only of being an accessory after the fact, but the authorities in Ontario had a clear cut case of murder in the other killing to which he had confessed while under the influence of scopolamine. After the woman had been convicted of the murder of her husband, her friend was taken to Canada where he paid the extreme penalty for the murder which would have gone unavenged were it not for this new and powerful instrument for the detection of crime--scopolamine.

XII

The cashier of a bank was suspected of covering up his shortage by manipulating his accounts and by even changing the dates upon some of his receipts. There was one receipt in particular which was questioned concerning the genuineness of its date. The year 1924 was written upon it, when in fact it should have been 1921. But there seemed to be nothing irregular about the figures themselves. Nevertheless, the bank officials consulted an expert in document examination.

[28]Cadaveric rigidity appears generally within five or six hours and disappears from twenty-four to thirty-six hours. Webster, *Legal Medicine and Toxicology* 76. (Much depends, however, upon the state of the body at death.)

[29]Scopolamine is used frequently in obstetrics cases under the commonly known name of "twilight sleep. " It was in such a case that the "truth telling," effects of the drug were first noticed. A few injections of scopolamine will depress the cerebrum to such a degree that it destroys the power of renewal, consequently paralyzing the "inventive faculty" of lying. See House, The Use of Scopolamine in Criminology, *Texas State Journal of Medicine* (Sept. 1922), (1931) *2 Am J. Police Sci.* 328.

After viewing the figures--1924--under a microscope, the handwriting expert suspected that different ink had been used in making the angular portion of the four than was employed in making the 1921. A bit of hydrochloric acid was placed upon all four numbers. The result plainly indicated an alteration, for the angular portion of the four turned a purple red, whereas the other figures turned blue green. Evidently iron gall ink had been used when the original figures were made, whereas the alteration was made with logwood ink. Both inks give different color reactions when they come in contact with hydrochloric acid.

Although the embezzler in this case made a good job of the actual penning of the forgery, he displayed his ignorance of inks when he used the wrong kind in making the alteration.[30]

XIII

In a homicide case the inference to be drawn from the nature of the wound and the circumstances surrounding the crime was that death had been effected by means of an axe or some such similar instrument. No clues were left at the scene of the crime. Nevertheless, suspicion fell upon a neighbor who was on unfriendly terms with the murdered man. This particular individual owned an axe, but a cursory examination of the instrument yielded no clue. Nearby, however, was found a piece of burned cloth with another bit of fibrous matter within. When questioned whether or not the charred mass contained some destroyed evidence, perhaps human hair or tissue wiped off the axe blade, the suspect stated that it consisted of house sweepings containing dirt and stray hairs from his pet watch dog. The explanation seemed plausible enough; there was no blood on the axe; there was a dog lying on the carpet by the door; the suspect's wife stated that her husband had not left home upon the night of the murder. In spite of all this, the burned mass, together with the axe, was taken to a laboratory for examination.

An expert made a careful study of the burned contents, and concluded that there was no trace of the presence of animal hair fibres, but he found distinct evidence that the so-called sweepings contained human hair. This was unbelievable. How could such an assertion be made after a microscopic examination of a mass of burned trash? And yet the evidence was unmistakable. The effects of burns upon human and animal hairs are vastly different.[31] Satisfied upon this point, a careful examination was made of the axe blade itself. It is almost impossible to clean a cutting edge sufficiently to prevent the finding of evidence under a microscope, and sure enough, imbedded in a niche upon the cutting surface was found a piece of hair fibre. Upon examination it was ascertained beyond doubt that the fibre was from the head of a human being, as evidenced by the arrangement of the pigment, which is entirely different from that of animal hairs. Moreover, this particular fibre found on the axe was similar in texture to that of the victim. And when slides of cross sections of the evidence hair were examined under the microscope, there appeared a striking similarity of the pigment. When confronted with the expert's finding, the suspect confessed to the crime. He himself attached considerably more weight to this than a jury might have done. At any rate he bemoaned the fact that he had not thrown his axe into a nearby stream, taking a chance of explaining away its absence.[32]

[30]See *Popular Science*, October 1931, for a similar case. For an account of the detection of forgeries as a result of study of the inks used, see Osborn, Questioned Documents 449 et seq.

[31]After being burned, hair of human origin has a tendency to hook over and twist back upon the unburned portion, whereas that of an animal does not. Supra note 27.

[32]Until scientific testimony is generally accepted in evidence, the results of scientific investigation prove to be of most value in inducing confessions, as suggested by this case.

XIV

The owner of a cheap rooming house seemed most unfortunate in the health and welfare of her boarders. Within a period of five years three of them had died, and apparently all had suffered from the same general ailment. In each case the owner collected on one or more life insurance policies. No one policy exceeded five hundred dollars, and for that reason the insurance companies did not concern themselves unduly with the peculiar surrounding circumstances. Finally another roomer, this time the woman's own nephew, died in a similar fashion. Needless to say, she was also the beneficiary under a policy taken out on the life of the deceased. Since death had resulted from a seemingly chronic condition, the physician, none too skilled in his profession, proclaimed death due to ulcerations of the stomach. Another relative of the deceased, however, became suspicious and requested that an autopsy be performed for the purpose of ascertaining whether or not there were traces of poisoning.

The report of the toxicologist attributed death to arsenic poisoning, and the police began their search for evidence by which they might determine the guilt of the suspect, if such were the fact. There were no traces of arsenic on the premises, and the neighboring druggists had no record of purchases of poison being made by the suspect. However, the investigators did locate in the basement of the rooming house an unusually large supply of flypaper of the toxic type. Although little significance was attached to this finding, the toxicologist who made the chemical analysis determining the true cause of the nephew's death was requested to examine the paper. He recognized it as that particular kind composed of a sugar coating containing sodium arsenite, and informed the prosecutor that it was a relatively simple matter for a person to soak the paper in a pail of water and thereby extract sufficient arsenic to obtain a lethal dose.

Armed with this circumstantial evidence, together with the auspicious factor of the insurance policies, prosecution was commenced against the accused. And the evidence proved to be so convincing that she is now serving a life sentence for the murder of her nephew.[33]

XV

The body of a young girl was found floating down a river. A post mortem examination indicated that the girl had been pregnant for about three months at the time of her death. An examination of the stomach contents indicated that shortly before her death the had eaten a large quantity of grapes.

There was village gossip to the effect that the young girl and one of her suitors had been holding tryst near the river in a garden in which there were numerous grapevines. Suspicion was cast upon the young man in question, but he denied having been near the regular meeting place within a week prior to the time when the body was discovered.

The investigators inferred that if the deceased had been eating grapes while in the orchard, her assailant probably did likewise. This prompted them to make an examination of a stool specimen of the suspected individual, but only after he had committed himself further by stating that he had not even eaten grapes within the previous week. Curiously enough the stool specimen, when examined under the microscope, revealed the presence of grape seeds as well as the undigested portions of grape skin. Thus science had exploded another seemingly perfect alibi.[34] Without further inquiry the suspect confessed that he had pushed the young girl into the river because of his fear of the consequences of an illegitimate birth to which he was a contributing factor.

[33]As to the scientific methods of detecting the presence of arsenic in human organs, see Blyth, Poisons: Their Effects and Detection 554 et seq., 5th ed. Also, Webster, *Legal Medicine and Toxicology.*

[34]See Gross, *Criminal Investigation.*

XVI

A man was found dead near the water front of a seaport, with his hand clutched about his own knife. From all appearances it seemed that the victim died while making a feeble gesture to stab his assailant as a means of protecting himself after he had been felled by a deadly blow from some blunt instrument. This suspicion seemed to be confirmed when the blade of the knife was examined carefully under a microscope. Upon it were fibres of some fabric, apparently from the trousers of the assailant

The results of the microscopic examination were very encouraging. The fibres on the knife blade were found to be of blue serge similar to the material used in the trousers worn by sailors.[35] It so happened that at that particular time there was a United States battleship in port. Consequently, the police authorities obtained permission of the commander to conduct an investigation. At the very moment when the officer and the investigators entered the crew's quarters there was a sailor seated upon his bunk mending a tear in the leg of his trousers. He was questioned as to the killing, and thereupon he readily admitted the homicide.

According to the sailor's story, he was returning to the ship in a slightly intoxicated condition when the deceased attempted to hold him up, faking his knife for a pistol. Upon discovering the sham, the sailor grappled with his assailant and then picked up a stick and struck him upon the head with it, which blow caused his death. Realizing his perilous position, he disposed of the bloody stick and hurriedly made his way back to the ship.

Police fingerprint records of the deceased were on file at the bureau of identification, and since the reason for their being there was due to the arrest and conviction of this particular individual for a similar crime committed five years previously, the truthfulness of the sailor's version of the affair seemed probable. As a result, the sailor appeared to have a certain defense, and the charge of murder against him was dropped. The solution of the affair, however, was dependent upon the careful study of a few tiny fibres hardly visible to the human eye.

Conclusion

The old sailing vessel, the stage coach, the horse and buggy all made a stand to retain their importance in the program of modern man. So it seems with all things as they approach the threshold of obsolescence. And the old time "common sense" detective is no exception. However, he is not likely to disappear completely. There will remain always a need for the detective who is acquainted with criminals and who knows their habits. In apprehending offenders much may be said in favor of the "drag net" methods. But guess work in dealing with suspects in most cases should be supplemented by deductions to be drawn from scientific data. All police departments must concede eventually that science can be of direct aid in the detection of crime, but at the same time the scientist must not forget that without the cooperation of an intelligent police force all his efforts would go, for naught. As an illustration: an expert in firearms identification can determine whether a certain gun fired the fatal bullet, but it remains for the police first to find the gun and then the man who fired it. As has been shown in most of the illustrations used in this article, science is of greatest importance in the verification of suspicion, but it is primarily the concern of the police to secure suspects and bring them to the scientist.

[35]A properly equipped crime detection laboratory will contain mounted specimens or enlarged microscopical photographs of the fibres of various clothing materials such as wool, cotton, linen, silk, etc., in the raw state as well as dyed. By comparison with known specimens, the particular fibre or fibres found upon the scene of a crime may give an indication as to the clothing worn by the criminal. See in this connection Barnes, The Identification of Cloth in Criminal Investigation, (1931) *4 Police Journal* 44.

Sooner or later the numerous methods of detecting crime scientifically will find their way into the courts as evidence of the guilt or innocence of an accused. In our zeal to safeguard the rights of a person on trial for a criminal offense, we have reached a point where the defendant seems to have all the advantages. The state must prove its case beyond a reasonable doubt. Ordinary circumstantial evidence often fails, and frequently only slight consideration is given to scientific evidence even in those cases where it is admissible. The criminal can utilize the latest scientific developments to commit a crime, but only a few of the latest methods of detection can be used to convict him. This defect in our administration of criminal justice is not attributable solely to the attitude of the courts. There remains a vast amount of research to be done in the field of scientific crime detection, and the field must be cleared of amateurs and "quacks." But reliability in scientific detection seems due to arrive before the criminal courts are ready with the stamp of approval.

Every step in the promotion of scientific crime detection is a step toward the abolition of the cruel and ineffective methods of establishing criminal identity, such as the "third degree," and also a step toward the realization of a criminal trial unhampered by technical procedure and unreliable evidence. The use of brutality by the police in securing confessions, the reception of flimsy testimony as to identity, and the ineffectiveness of circumstantial evidence may be curtailed by more reliance upon scientific data and less reliance upon individual "reasoning."

Some Avoidable Lie-Detector Mistakes

Fred E. Inbau

In this article Professor Inbau discusses with commendable frankness some of the difficulties attending the lie-detector technique. His views upon this subject were presented at a meeting of the Academy of Forensic Sciences in Chicago, on January 26, 1950. The author, a Professor of Law at Northwestern University, was formerly Director of the Chicago Police Scientific Crime Detection Laboratory. Professor Inbau's book "Lie Detection and Criminal Interrogation," which is now in the second printing of the second edition, is recognized as the authoritative work in this field--EDITOR.

The most competent lie-detector examiner may and does make mistakes, and in a certain percentage of his cases he is unable to arrive at a definite opinion as to whether his subject is telling the truth or lying. Nevertheless, many lie-detector errors and inconclusive test results are avoidable ones. The factors which generally account for this latter group may be briefly stated as "unfit subjects" and "unqualified examiners."

Subjects Unfit for Testing

Most lie-detector errors and inconclusive test results are attributable to the incompetency of the examiner conducting the test. In many instances, however, they are properly chargeable to a prevailing practice whereby otherwise qualified examiners will accept for test purposes subjects who have been rendered unfit for any such testing because of the treatment they have encountered at the hands of police investigators before being presented for lie-detector tests.

No one in his right mind would expect a medical technician to conduct a satisfactory metabolism test on a patient who had just emerged from a fist fight or who had been chased up a flight of stairs or who had been verbally abused and threatened while on his way to the examination room. Yet the thought apparently seldom occurs to some police investigators that a person may be rendered unfit for a lie-detector test by an extensive interrogation based upon frequent and constant accusations of guilt. In many of these instances, the lie-detector examiner is unable to make a diagnosis that he considers reliable; his report is "indefinite" or "inconclusive," and so the press report reads too. In cases where the extensive interrogation is accompanied by actual physical abuse, the positive suggestions of guilt constituting part of the "third degree" procedure may produce test reactions which will simulate true deception criteria in an innocent person's record. There is at least one such case in which this actually happened. The same pre-test experience also may so condition a guilty subject that his enmity toward the investigators becomes the center of his thinking rather than the offense itself, and the ordeal may actually relieve him of whatever mental conflicts are present because of his criminal act. In this event it is highly probable that a "third degree" victim's deception may not be detected by the lie-detector technique, and another lie-detector failure will probably find its way into the press reports.

Any testing which is attempted under the conditions just described is unfair to the lie-detector technique and to the examiner as well.

Experience on the part of competent examiners who restrict their practice largely to personnel investigations indicates that their percentage of accuracy and of definite reports far exceeds that of examiners in police cases. The difference may be attributed in large part to the fact that the personnel investigator's subjects are in much better condition for their tests. They have not been physically abused or extensively interrogated.

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What can the police-employed lie-detector examiner do to remedy the present situation? Three things:

1. Establish a practice of refusing to test a subject who has been physically abused.
2. Where the circumstances are in the extreme, refuse to examine a subject who has been extensively interrogated, even though no direct physical abuse has been administered.
3. Try to develop a procedure within the particular police department whereby lie-detector tests will ordinarily be conducted during the early stages of an investigation or interrogation rather than as a last resort when all else has failed.

To some persons these suggestions may appear to be naively conceived. They will say that only a very unrealistic individual will expect a lie-detector examiner who is working in or for a police department to adopt such an attitude and survive the consequences. In the writer's opinion, however, a person who does not have the necessary courage or the ability to meet the situation is unfit for the role of lie-detector examiner.

The Basically Unqualified Examiner

In assessing the qualifications of a lie-detector examiner, it must be remembered that his task is not simply the manipulation of an instrument; as a matter of fact the actual operation of the instrument itself requires very little ability or training. The examiner's most important task and responsibility consists of the diagnosis of deception from an examination and study of the physiological changes recorded by the instrument. Along with his skill in that respect, however, lie must be able to perform the next most important task-the skillful interrogation of a guilty subject with a view toward obtaining a confession of his guilt.

To qualify for this two-fold assignment, an examiner need not be a physician or a psychologist, but he must be an intelligent person with a reasonably good educational background-preferably college training. He should have an intense interest in the work itself, a good practical understanding of human nature generally, and suitable personality traits which may be evident from his otherwise general ability to "get along" with people and to be well liked by his friends and associates. Unless he has these qualifications, no amount of training or experience will permit him to produce very satisfactory results either as regards the accuracy of his deception diagnosis or his record for confessions obtained from guilty subjects.

Many persons now functioning as lie-detector examiners do not possess these basic qualifications. They should never have been encouraged to embark upon such a career. Unfortunately, however, a number of established examiners have conducted schools for trainees and have followed a practice of accepting as students practically anyone who applied with the necessary tuition fee or who had been selected by his own police department or governmental agency to attend the school at his employer's expense.

A person without a better-than-average intelligence, a fair educational background, and a good practical understanding of human nature generally, will inevitably make more mistakes than a trained individual with the necessary basic qualifications. The basically unqualified examiner is the one who in view of his own personal shortcomings will feel impelled to make a definite diagnosis in practically every case, and for that reason is more likely to make outright mistakes. To him an indefinite report is an admission of personal failure. He is also less likely to succeed in private practice as a lie-detector examiner if he makes such an attempt, and with a realization of impending failure he will be more receptive to rendering opinions favorable to that side in a controversy or investigation which is prepared to pay the higher price for a suitable opinion.

No experienced examiner who values the status of the lie-detector technique or his own reputation should accept for training, at whatever the price may be, individuals who are basically unqualified.

Inadequate Training

Although it is possible for a person with proper basic qualifications to ultimately develop into a competent examiner after several weeks of intensive study, instruction, experimentation, and actual case observations,

the desirable minimum period of training is about six months. During that time his course of study should include readings and instruction in the pertinent phases of physiology and psychology; frequent observations of an experienced examiner working on actual cases; personal experience in experimental case testing and actual case testing under an instructor's supervision; and the examination and interpretation of a considerable number of records in solved cases. His course of training should also include instruction, as well as observational and personal experience, in the application of psychological tactics and techniques for obtaining confessions and other helpful information subsequent to the testing of untruthful subjects.

Regardless of the time element, however, adequate training cannot be given by an instructor to more than about six persons at a time. The student in larger groups cannot acquire the necessary practical experience or receive the individual attention required from the experienced examiner. Here again, therefore, is a prevailing practice that should be modified in the interest of better examiners and fewer mistakes.

During and after any course of instruction the student should be made to realize fully that the technique is subject to limitations and that he should not represent it to agencies utilizing his service as possessing any infallibility in its indications.

Some branches of the armed services have used and are perhaps still using as examiners certain individuals who are basically unqualified and improperly trained. They have at times conducted tests--and on a large scale basis at that--upon persons whose loyalty was under scrutiny, and in many instances the reports of these examiners appear to have been accepted at face value and upon the assumption that the technique produced results approximating perfection. For the future welfare of this nation, let us hope that somewhere along the line of persons responsible for the security of our secret weapons or of any other project or interest of national importance there develops a realization that the dependability, of lie-detector test results is no greater than the qualifications and ability of the examiner himself. Moreover, there should be an awareness that even as regards a highly qualified examiner mistakes are still a possibility.

The Need For Specialization

Mastering the lie-detector technique is no simple matter. It requires much time and effort. In fact it requires all of one's working time and energy. An examiner cannot do justice either to the technique or to himself if one day he is a chemist or a firearms expert, and the next day, or hour, he functions as a lie-detector examiner. Moreover, the personality requirements for a lie-detector examiner are vastly different from those of laboratory technicians generally. As a rule the man who is good with the microscope or chemicals either does not have the required interest in testing and interviewing people or else he lacks the essential personality characteristics. By this suggestion no reflection is intended, of course, upon the laboratory technicians; in fact, the situation is no better when reversed. The capable lie-detector examiner is usually a misfit when he tries to work in these other fields.

It is a mistake, therefore, for any police department to assume that laboratory personnel can be readily shifted from a chemistry section or a firearms section into the laboratory's lie-detector unit. It is also unwise for an individual to attempt to shift back and forth from the one type of work to the other. He should realize quite early in his career that the lie-detector technique, like the profession of law, is a "jealous mistress." It will demand and require his undivided attention.

Conclusion

The lie-detector technique, when properly used, is an invaluable investigative aid; and it is being so used by a number of very able examiners. At the same time, however, we must recognize the existence of certain objectionable practices which retard the progress of the technique and contribute very materially to the making of otherwise avoidable mistakes. Only by a recognition of these shortcomings and a frank discussion of the problem can we invoke the necessary corrective measures.

Scientific Evidence in Criminal Cases

II. Methods of Detecting Deception*

Fred E. Inbau

A. The "Lie-detector":

Long before psychologists ever attempted to develop a scientific technique for detecting deception, persons of average intelligence must have observed the fact that conscious lying ordinarily produces certain emotional disturbances--such as blushing, squinting of eyes, squirming, peculiar monotone of the voice, throat pulsation, cold sweat, and a host of other manifestations.

These phenomena were not merely observed and then set apart for psychological theorizing. They actually played, and still play, an important role in practical affairs--especially so in our judicial system. Every judge and every jury--perhaps unknowingly--gives considerable weight to the physical reactions when an accused person or a witness is giving testimony in the trial of a case. And this has received judicial sanction. A court may even go so far as to instruct the jury that in determining the credibility which should be accorded to the testimony of a defendant in a criminal case they may take into consideration his demeanor and conduct both upon the witness stand and during the trial.[1] Moreover, it is very generally held that the conduct, demeanor, and words of one

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*An extended discussion concerning the "word-association" test is purposely omitted in this paper for the reason (1) that its status has not judicially determined, and also (2) because of the fact that it does not seem to possess the encouraging possibilities of a "lie-detector" or a "truth-serum," since the "word-association" test only indicates *a consciousness of guilt*, whereas the other two methods *may reveal the lie itself*. (The purpose of discussing hypnotism is due mainly to the fact that the question has been passed upon by the courts, rather than because of any special merits of hypnotism itself, as will be discussed later.)

The technique in conducting the "word-association" test consists of giving the subject certain stimulus words, one at a time, to which he must respond by speaking the first word that comes to his mind. Among the words given there are a few crucial (pertaining to the crime) and many more non-crucial (irrelevant). The nature of the response word and also the time reaction (there being some method used for accurately timing the interval between stimulus and response) are both significant in determining whether or not there is a consciousness of guilt. For detailed information see Muensterberg, On the Witness Stand (1909, 1923); Marston, "Reaction-Time Symptoms of Deception," *3 Jour. of Experimental Psychology* 72 (1918), *ibid.* "Negative Type Reaction-Time Symptoms of Deception," 32 *Psychological Rev.* 241 (1925); Langfeld, "Psychophysical Symptoms of Deception," 15 *Jour. of Abnormal Psychology* 319 (1920); Goldstein, "Reaction Times and the Consciousness of Deception," 34 *Am. Jour. of Psychology* 562 (1923); Crossland, "The Psychological Methods of Word-Association and Reaction-Time as Tests of Deception." 1 *Psychology Series.* University of Oregon Publications No. I (1929); Spencer, "Methods of Detecting Guilt: Word Association, Reaction-Time Method," 8 *Ore. L. Rev.* 158 (1929); Wigmore, Principles of Judicial Proof 621 *et. seq.* (1931). For an interesting discussion of Professor Muensterberg's criticism of the legal profession's refusal to utilize this test, see Wigmore, "Professor Muensterberg and the Psychology of Testimony," 3 *Ill. L. Rev.* 399 (1909).

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[1] "We know it to be a fact, grounded in human nature that the conduct of a defendant or a party to a suit during the trial is more or less potential, and has necessarily more or less weight with the court and jury upon the question of his credibility. . . . If this be so, we fail to perceive the vice in an instruction telling the jury that they may do the very thing which common experience and common observation teach that the human mind inevitably will do." Boykin v. People, 22 Colo. 496, 45 Pac. 419 (1896). See 1 Wigmore, Evidence (2d. ed. 1923) §274. Contra: *Purdy v. People*, 140 Ill. 50, 29 N. E. 700 (1892).

charged with crime, about the time of its commission or of its discovery, or upon his arrest for or upon his accusation of it, are admissible as evidence against him.[2] It is apparent, therefore, that the notion of detecting deception by utilizing certain psycho-physiological principles is not entirely new.[3]

In their efforts to develop an accurate and reliable "lie-detector," scientific investigators have obtained the most encouraging and satisfactory results from experimentation regarding the symptomatic changes in respiration and blood pressure.

Lombroso is reputed to have been the first to experiment with the heart-beat in an effort to determine the guilt or innocence of a suspect.[4] But perhaps the real step toward the development of a deception test is found in the efforts of Benussi[5] who detected significant changes in the inspiration-expiration ratio of the person under interrogation.[6] Since then the further study of scientific methods for detecting deception, based upon the cardiac changes suggested by Lombroso and the respiratory changes noted by Benussi, has been carried on in this country--principally by W. M. Marston, John A. Larson, and, Leonarde Keeler.

Keeler who perfected the "lie-detector" known as the Keeler Polygraph (the most reliable instrument up to this time),[7] and who is at present Assistant Professor of Law (in Legal Psychology) at the Scientific Crime Detection Laboratory of Northwestern University, has conducted approximately ten thousand deception tests within the past eleven years. (In the last three he has been assisted by Charles M. Wilson.)

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[2] "Any indications of a consciousness of guilt by a person suspected of or charged with crime, or who may after such indications be suspected or charged are admissible evidence against him. The number of such indications it is impossible to limit, nor can their nature or character be defined." *McAdory v. State.* 62 Ala. 154, 159 (1878). "From our knowledge of the human mind and its workings, we expect, with almost positive certainty, that when it is the sole repository of so dreadful a secret it will affect the conduct and sayings of the person; hence the mind naturally looks to these with the most anxious scrutiny, and would require for its satisfaction, if such a thing were possible, a complete transcript of the person's conduct and sayings. . . See 1 Wigmore, Evidence (2d ed. 1923) §273.

[3] There is an age-old practice in the Orient of requesting an accused person to chew rice and then spit it out for examination-and if the rice is dry the suspect is considered guilty, because his fear of guilt is supposed to inhibit the secretion of saliva. In India the movement of the suspect's big toe is supposed to be an indication of deception. See Larson, "The Berkeley Lie Detector and Other Deception Tests," 49 *Am. B. Ass'n Rep.* 619 (1922), 40 *Medico-Legal Jour.* 14 (1923).

[4] Larson, Lying and Its Detection (1932) 172. For a brief history of the development of deception tests in general see an excellent article by Professor C. T. McCormick, in which he made a thorough survey of this subject up to 1926: McCormick, "Deception Tests and the Law of Evidence," 15 *Cal. L. Rev.* 484 (1927) 6 *Tenn. L. Rev.* 108 (1928), 2 *Am. J. Police Sci.* 388 (1931).

It is interesting to note that Benvenuto Cellini records in his autobiography the following observation concerning his father: "I was ill about two months, during which time my father had me most kindly treated and cured, always repeating that it seemed to him a thousand years til I got well again, in order that he might hear me play a little. But when he talked to me of music with his fingers on my pulse, seeing he had some acquaintance with medicine and Latin learning, he felt it change so much if he approached that topic, that he was often dismayed and left my side in tears."

[5] See Benussi, V., "die Atmungsymptome der Luge," 31 *Archiv fur der Gesamte Psychologie* 244 (1914).

[6] Professor Burtt of Ohio State University confirmed these findings and also made further studies of deception. He states, however, that the changes in quantitative systolic blood pressure are the most important criteria. See Burtt, *Legal Psychology* (1931). In this connection see Landis and Gullette, "Studies of Emotional Reactions (III.) Systolic Blood Pressure and Inspiration-Expiration Ratios," 5 *Jour. of Comparative Psychology* 221 (1925).

[7] See Larson, "The Use of the Polygraph in the Study of Deception" (Department of Public Welfare Publication, Illinois, Series No. 104, at p. 6) (1927). Also see Larson, *Lying and Its Detection* (1932) xv, Mention should be made of the fact that there are only about ten such instruments now in use. However, practically every university psychology laboratory has what is usually labeled a "lie-detector"--a galvanometer. (See note 9.) Frequently amateurish experimentation with such an instrument accounts for the unfavorable newspaper comments to the effect that there is no means for detecting deception. It is unfortunate, therefore, that the catch-word "lie-detector" was ever used, without any qualification to distinguish one type of instrument from another.

The instrument consists of three units: one for recording respiratory changes; another for continuously recording the pulse wave and blood-pressure; and a third for recording a duplicate blood-pressure-pulse curve or for recording muscular reflexes of the arm or leg. (Ordinarily only the first two units are used; the third serving merely as an accessory.)

For obtaining these bodily reactions, a rubber tube (pneumograph) is placed around the chest, and a blood-pressure cuff, of the type ordinarily used by physicians, is fastened about the upper arm and then inflated to a pressure about midway between the systolic and diastolic blood pressures. Rubber tubes of approximately one quarter of an inch in diameter lead from both the pneumograph and the cuff into metal tambours to which are attached two stiluses. At the tip of each stilus is a small cup which is kept filled with ink and which feeds the pens as they fluctuate with each pulse beat or respiratory movement. The recordations are made upon slowly moving graph paper driven by a small synchronous electric motor.[8]

An instrument of this type should be distinguished from the numerous other so-called "lie-detectors" frequently found in the psychology departments of many universities. Usually such experimental devices consist of a galvanometer and Wheatstone bridge--an instrument for observing the psycho-galvanic reflex, that is, the changes in skin resistance to an imperceptible current of electricity flowing through the subject's body during the period of questioning. The galvanometric change in the body serves as an extremely sensitive criterion for emotionality, but cannot by itself be depended upon as a means for the detection of deception. Used, however, in conjunction with the other two reactions (blood-pressure and respiration), it may be of considerable assistance. The new Polygraph will contain this unit in addition to the others previously mentioned[9].

Physiological irregularities, such as high blood pressure, etc., or emotional instability caused by worry or psychological strain, do not interfere with the deception test, because these factors are ascertained in the "control" part of the record.[10] In other words that part of the record made by the subject while being asked the few customary irrelevant irrelevant questions (e.g. have you had breakfast this morning?)[11] will indicate the

[8] For more detailed description see Keeler, "A Method for Detecting Deception,"1 *Am J. Police Sci.* 38 (1930).

[9] A "lie-detector" must record two or more bodily changes, for no one known change can be depended upon to give true :and significant responses to deception. The psycho-galvanic reflex is a valuable indicator in many cases, but results with it alone cannot be relied upon. The blood pressure, pulse, and respiration are indespensable responses if we are to get a reliable cross-section of psycho-physical reactions. A record of the combination of all three bodily variations is most desirable for detecting deception.

[10] There should be a qualification to the foregoing statement which, perhaps may be adequately explained by the following illustration: In the recent Wynekoop murder case in Chicago, the police had grilled an elderly woman suspect, Dr. Alice Wynekoop, for about seventy hours, at the end of which time a member of the Scientific Crime Detection Laboratory Staff was called upon to make a "lie-detector" test upon the suspect. A test was made, but the operator found the subject in a weakened condition and with a blood pressure of about two hundred and twenty. Because of this fact he refused to make public any statement concerning the results so obtained, until he could make another test under more favorable conditions—after the suspect had received some undisturbed rest. The police then placed her in a cell, supposedly for the purpose of rest and sleep, but actually as bait for newspapers reporters and photographers. They then requested another test, which was refused by the operator, because of non-compliance with his request regarding the period of rest and quiet. Hence the unfavorable newspaper reports to the effect that "Dr. Wynekoop thwarts the 'lie-detector' " See newspaper accounts in Chicago papers from November 21, 1933, until December 11, 1933.

It should also be stated that the instrument's reliability is restricted to cases involving conscious deception. In other words, it is of little value in cases involving pathological lying—such as the case of a paretic who speaks of his millions, etc. See Larson, The Cardio-Pneumo-Psychogram in Deception, 6 *Jour. of Experimental Psychology* 420 (1923).

[11] All questions are so framed that they may be answered by "yes" or "no." The reason for this is obvious, because any speaking by the subject will interfere with the recording of the otherwise normal automatic respiration and heart-beat, and thereby impair the recording of the variations caused by emotional disturbances due to conscious lying. Before each test the subject is cautioned to refrain from conversing, and merely answer by either "yes" or "no"—reserving his explanations until the completion of the test.

physiological peculiarities of the particular individual. Significance is attached only to the deviations from the "norm" at the points where the subject is being interrogated as to his participation in the crime under investigation.

Within the past three years approximately forty-five Chicago banks have availed themselves of the "lie-detector" as an aid in detecting embezzlement among employees, and also for the purpose of ascertaining whether or not a prospective employee has been guilty of any previous unknown irregularities under former employers. The results so obtained by members of the Scientific Crime Detection Laboratory staff have been extremely interesting and most gratifying--to the investigators and to the banks as well.

In the banks where all employees, from president to janitor, have been examined for the first time, the polygraph records of from ten to twenty-five percent of the personnel have indicated deception in the answers to questions pertaining to the taking of money from the institutions or from customers. And practically all such records have been substantiated by admissions of the subjects themselves.

In one instance a bank desired to have polygraph tests made upon its fifty-six employees in an effort to detect the embezzler of a sum of five thousand dollars. Instead of finding one liar in the group, twelve were discovered. Of these twelve, nine confessed to embezzlements heretofore unknown to the bank officials.[12]

Six bank applicants were sent to the Laboratory recently for polygraph tests to determine whether or not they had been guilty of converting to their own use any money or property belonging to previous employers. Only one of the six ran a clear record on the instrument. The other five gave specific responses indicating deception in their answers to such questions, and each of these admitted having diverted various sums of money plus other miscellaneous articles.

Not every bank employee or bank applicant with a guilty record is dismissed from the institution or refused employment. The individual who admits *all his irregular practices* is usually retained, or employed, even in many cases where substantial sums are involved.[13] Past experience lends support to the theory that such an employee is a "good risk," not only because of the beneficial psychological effect accruing from the admissions but also because he is aware of the fact that within another six months or a year he will be subjected to another similar test, the outcome of which must be favorable in order for him to retain his position in the institution.

The Chicago Police Force only occasionally requests the assistance of the "lie-detector," although such Laboratory service was formerly offered free of charge to the law-enforcing agencies of that city.[14] Neighboring communities, however, frequently solicit the

[12]Recently in one of Chicago's largest banks, several individuals were examined regarding the disappearance of a small sum of money. One of those whose record indicated deception in his answers to pertinent questions finally confessed to taking four thousand five hundred dollars, two thousand two hundred of which was from a charity fund—"tag day" money cans, which this particular subject had opened for the purpose of counting the money and depositing it to the account of the charitable organization involved.

[13]After any admissions, further polygraph tests are made to determine whether or not the subject continues to withhold information as to his dishonest practices. When complete confessions are made the polygraph records are usually free from specific responses.

[14]Several police captains have developed considerable respect for the instrument because of the results obtained in cases arising in their particular districts. However, the general attitude of the Chicago police department toward the "lie-detector" is quite clearly depicted in the following incident. At the time of the Wickersham investigation a leading police official was asked why he neglected to use the "lie-detector" in his investigations, to which he replied (with a display of his clenched fist): "Here is the best lie-detector." See Report No. 11 of the National Commission on Law Observance and Enforcement: Lawlessness in Law Enforcement (1931) 130. A comment is there made to the following effect: "The presence in Chicago of this Laboratory, with its many scientific facilities, ought in time to stimulate the local prosecuting attorneys and detectives to place an increasing reliance on the investigation of outside evidence of crimes instead of the extortion of confessions by brutal methods."

aid of this instrument. Only recently, at Rock Island, Illinois, a large number of persons were quizzed in an effort to determine the slayer of a young girl. The evidence against any one of the suspects was not more than that against the others. All of them were tested upon the "lie-detector," and the records obtained indicated deception on the part of but one of the suspects. Before arrangements could be made for his arrest, this particular individual became a fugitive from justice by leaving town that very day. Some two weeks later he surrendered, and thereupon confessed his guilt. He was tried, convicted, and sentenced to ninety years in the state penitentiary.[15]

In another rather interesting case,[16] two suspects of a bank robbery were tested at the request of their attorneys. The records secured were clear and not indicative of any deception. At the trial of these two men, permission was obtained from the judge to call a night session with the jury absent, in order to have a demonstration of the test and to receive the testimony of both Keeler and Larson. As was expected, however, the prosecuting attorney objected to the introduction of the testimony, on the ground that such would be a usurpation of the function of the jury. The objection was sustained and the trial proceeded as usual. Three witnesses were placed on the stand who swore that they *saw* the defendants commit the crime. Two days later the real bank robbers were apprehended elsewhere and they confessed to this particular robbery. Naturally, the innocent defendants were released. And from that time on the prosecuting attorney in the case has come to have considerable confidence in the "lie-detector." He, himself, later called upon Keeler for his assistance in a murder case, in which the suspect whose record indicated deception confessed to the crime in question.[17]

Although no claim is made as to the infallibility of the Polygraph deception test technique, statistical data definitely establish the fact that it is an extremely valuable method for establishing guilt or innocence. In experimental cases, the outcome of which is of no importance to the individual being tested, there is an accuracy of approximately eighty-five per cent. And frequently in those instances where no significant response is given, if a monetary wager is made with the subject that his lie can be detected (i. e., chosen card, chosen number, etc.), the existence of this "stake" will cause a significant response to be recorded on the instrument. In criminal cases, statistical data are difficult to obtain. For instance, in cases where a suspect's Polygraph record contains significant responses indicating his guilt, but no substantiating or discrediting evidence is ever obtained by the police, and no admissions are made by the suspect himself, such a record will remain "an unknown quantity" as far as statistical data are concerned. Nevertheless, in numerous criminal cases, full confessions

[15]See newspaper accounts of this case, and of the part played by the "lie-detector," in the "Chicago Herald and Examiner" of February 19, 1933; the "Chicago Herald and Examiner" for May 9. 1933; and the "Chicago Daily Tribune" for May 10, 1933. Also see complete account in the American Weekly section of Hearst's newspapers of June 11, 1933. The defendant was Maurice Meyer and the victim Rose Gendler. The "lie-detector" evidence was not used at the trial, however. See "Davenport Democrat" for April 18, 1933.

[16]See report in Larson, *Lying and Its Detection* (1932) 349.

[17]Another interesting case in which Keeler participated was the one centered about the trial of Virgil Kirkland at Valparaiso, Indiana, in 1931. Kirkland was accused of a rape and murder. He was tried. convicted. and sentenced to death. Upon appeal the conviction was reversed on the ground of insufficient evidence to support the jury's verdict. Prior to the second trial, defense counsel procured the services of Mr. Keeler. He tested Kirkland on the "lie-detector" and the record indicated Kirkland's innocence of the major charges of the crime. At the trial Keeler was called as a witness and he proceeded to testify before counsel for the prosecution objected. The objection was sustained. Nevertheless, on motion of defense counsel, the jury was removed from the court room and the judge heard testimony regarding the "lie-detector." Any further "lie-detector" testimony was withheld from the jury. The verdict upon this second trial amounted merely to a conviction of assault and battery with intent to commit rape and the defendant was sentenced to the state penitentiary for one to ten years. Observers have stated that the fact that the defense offered to prove, and was deprived of the right to prove the truthfulness of the defendant's testimony by means of the "lie-detector" had considerable weight in the jury's deliberations. See newspaper accounts of this case in the "Chicago Herald and Examiner" of May 21, 22, 1931.

have been obtained in approximately seventy-five per cent of those in which the record indicated deception regarding the pertinent questions propounded of the suspect.

It must be remembered that the successful use of any such device depends largely upon the skill of the operator in selecting the questions propounded and in correlating the emotional responses. This is something an untrained individual cannot do. And for that reason Professor Keeler has attempted to limit the distribution of the instrument to individuals who have demonstrated their ability as operators and who are either reputable members of the medical profession, or officially connected with educational institutions or recognized law enforcing agencies. An instrument of this nature in the hands of an unscrupulous individual is an extremely dangerous thing.

Decisions

In a federal case decided in 1923, *Frye v. United States*,[18] the defendant, on trial for murder, offered as evidence the testimony of W. M. Marston concerning the result of a deception test made upon the defendant by use of the "systolic blood pressure" method. The testimony was excluded by the trial court and upon appeal the decision was affirmed. The following extract from the opinion of the appellate court represents a truly intelligent treatment of a problem of this nature:

> "Just when a scientific principle of discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.
>
> "We think that the systolic blood pressure deception test has not yet gained such standing and scientific recognition among physiological and psychological authorities as would justify the courts in admitting evidence deduced from the discovery, development, and experiments thus far made."[19]

Three years after this decision, in 1926, Professor C. T. McCormick[20] sent questionnaires to various members of the American Psychological Association in an effort to ascertain their opinions upon the question of whether or not the results of the deception tests based upon the measurement of the word-association reaction time, respiratory changes, and blood pressure were of sufficient accuracy to warrant consideration by judges and jurors in determining the credibility of testimony given in court. Of those who replied, eighteen answered yes, with varying qualifications (e. g., if handled by an expert only), thirteen answered no, and seven were of doubtful classification[21].

Since 1926 considerable progress has been made in the field of detecting deception[22]. But no one is yet prepared to assert that even the most advanced method for detecting

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[18]293 Fed. 1013, 34 A. L. R. 145 (D. C., 1923).

[19]*Ibid.* pp. 1014; 146. "The attitude of the court in this case seems beyond all criticism. It will not do to declare dogmatically that there is no good in a new thing, and it will not do, particularly in a capital case, to let scientific theories as yet unproved to disturb the scales. The court displayed a proper caution, yet left an open door for the 'coming light.'" 28 Law Notes 64 (1924). See notes on this case in 24 *Col. L. Rev.* 430 (1924); 37 *Harv. L. Rev.* 1138 (1924); 2 *N.Y. L. Rev.* 162 (1924); 33 *Yale L. J.* 771 (1924).

[20]At that time Professor of Law, North Carolina University, and now professor of Law at Northwestern University.

[21]See McCormick, "Deception Tests and the Law of Evidence," 15 *Cal. L. Rev.* 484, 495 (1927).

[22]The years from 1930 have witnessed the greatest strides along this line.

deception is infallible. However, perfection is not a prerequisite to judicial recognition. Professor Wigmore, in discussing scientific evidence in general, has stated that,

> "All that should be required as a condition is the preliminary testimony of a scientist that the proposed test is an accepted one in his profession and that it has *a reasonable measure of precision in its indications*".[23]

No one, at least for some time to come, will advocate that "lie-detector" evidence alone sustain a conviction. But as a test of credibility of either the accused or of a witness, it might well serve as a link in the chain of circumstances indicating guilt or innocence. This suggestion finds ample support in the present practice of admitting evidence that blood hounds have followed a trail from the scene of a crime to the whereabouts of the accused,[24] of evidence of similarity of foot-marks,[25] and of conduct to show insanity[26]--"all striking examples of the fact that the conclusiveness in the inference called for by the evidence is not a requirement for admissibility."[27]

The use of a "lie-detector" in court, or the admission of testimony concerning tests conducted before trial, involves a consideration of certain privileges guaranteed an accused by both federal and state constitutions. This problem was raised in the recent Wisconsin case of *State v. Bohner*,[28] which rejected the offer of defense counsel to introduce "lie-detector" testimony as to the truthfulness of the defendant's, alibi.

The opinion of the appellate court in the *Bohner* case contains a quotation from defense counsel's brief, to the effect that the defendant offered to prove "by Prof. Leonarde Keeler, of the Northwestern University Crime Detection Laboratory, of Chicago, Illinois, by a test upon the defendant and with his instrument known as the 'lie detector' that the defendant was not in the city of Tomah on the date of the robbery and was not guilty."[29] This language has conveyed the impression that Mr. Keeler actually conducted the tests, and that he participated in the trial of the case. As a matter of fact, however, *he did not test the defendant.* The extent of his participation consists of correspondence with defense counsel, in which Mr. Keeler consented merely to examine the defendant and to render a report to defendant's counsel. Moreover, Mr. Keeler advised and requested that no attempt be made to introduce evidence either as to his willingness to conduct the test or as to any report he might render upon the result of the test--it being thought advisable to await a more favorable opportunity to seek judicial recognition of such evidence, and at a time when more complete data and information could be presented for the court's consideration. Nevertheless, the present decision represents a refusal to admit "lie-detector" evidence in a criminal proceeding.

The constitutional law aspect of "lie-detector" testimony was not mentioned in the *Frye* case, but in the *Bohner* case the Wisconsin court considered this phase of the problem in addition to the other involving the admissibility of scientific evidence "not yet generally accepted in its own particular field."

> "While it (the 'lie-detector'] may have some utility at present, and may ultimately be of great value in the administration of justice, it must not be overlooked that a too hasty acceptance of it during this stage of its development may bring complications and abuses that will overbalance whatever utility it

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[23]2 Wigmore, Evidence (2d ed. 1923), §990. (Italics added)
[24]State v. Adams, 85 Kan. 435, 116 Pac. 608, 35 L. (n.s.) 870 (1911); State v. King, 144 La. 430, 80 So. 615 (1919). See also 8 R. C. L. §177 (1915).
[25]People v. Breen, 192 Mich. 39, 158 N. W. 142 (1916); State v. McLeod, 198 N. C. 649 (1930), and see note on this case in 5 Temple L. Q. 144 (1930).
[26]1 Wigmore, op. cit. supra note 23 at §229 et. seq.
[27]McCormick op. cit. note 21 at p. 500.
[28]N. W. 314 (Jan 10, 1933)
[29]N.W. 317.

may be assumed to have. The present necessity for elaborate exposition of its theory and demonstration of its practical working, in order to convince the jury of its probative tendencies, together with the possibility of attacks upon the soundness of its underlying theory and its practical usefulness, may easily result in a trial of the lie-detector rather than the issues in the case. If the defendant in a criminal case is to be permitted to have tests taken outside of court and then to introduce expert testimony as to the results of the tests when these are favorable to him, without the necessity of taking the stand or submitting to tests by the prosecution, the way would seem to be open to abuses that would not promote the cause of justice. It is our conclusion that the refusal of the trial court to admit this testimony was not error."[30]

The objection raised by the Wisconsin court in the foregoing case as to the undue advantage which would thus be given a defendant under such conditions is easily met by the suggestion that whenever a defendant seeks to introduce testimony of this nature he will be considered as having waived his privilege of refraining from taking the witness stand. Another way to handle the situation, where the accused wants to subject himself to the test, and perhaps one more desirable, is (1) to require defense counsel to make an application to the court for an order that the test be made in the presence of attorneys for both prosecution and defense, and (2) for the court to attach a condition that the report of the expert conducting the test be admitted in its entirety, whether favorable or unfavorable thus constituting a complete waiver of the defendant's privilege against self-incrimination. This also would meet the objection voiced by the Supreme Court of Wisconsin.

Where the suspected individual refuses to submit to the test, his constitutional guaranty against self-incrimination may seem to afford him protection against a compulsory examination. And yet, upon the analogy of several other types of cases there should be no valid objection on this ground. For instance, an accused person may be compelled to stand up in court for the purpose of indentification,[31] to place his feet in a suitable position for view by the jury;[32] to make footmarks for comparison with those found at the scene of the crime;[33] to make fingerprints for the same

[30]*Ibid.* p.317. In support of its position that the evidence was not sufficiently reliable for use in criminal trials the court quoted from Wigmore's "Principles of Judicial Proof" (2d. ed. 1931) 634, wherein the author summarized his preceding discussion of all sorts of experimental psychometric methods of ascertaining data for valuing testimonial evidence—such as the "word association" test, the "truth-serum" tests, etc. The court inferred that Professor Wigmore offered "little comfort to one who contends that this device is past the experimental stage." As a matter of fact, Professor Wigmore devoted considerable space in his book to a discussion of the "lie-detector," and his attitude, both as indicated in his work and as expressed to the writer recently, is far from discouraging. Moreover, Professor Wigmore has been criticized for being "a little uncritical in his acceptance of these recent devices," and for not showing that "finger-print, bullet marks scopolamine, and lie detectors are also fallible tests." See book review by Professor Chafee of Wigmore's "Principles of Judicial Proof" in 80 *Pa. L. Rev.* 319, 322 (1931). Incidentally. Professor Chafee objected to Wigmore's omission of any mention of Whedde & Beffel's "Finger-prints Can Be Forged," but Professor Chafee himself did not mention the fact that both authors of this book are ex-convicts, and that an investigating committee of the International Association of Identification discredited the assertions made by Whedde and Beffel. Professor Chafee also stated in his review that "the Wickersham Commission has reported a Washington case where an injunction was issued against scopolamine injection and the use of the lie detector." But, as indicated by the following quotation, there is nothing in the injunction decree which discredits the "lie-detector": "It is not for this court (Superior Court of Washington) at this time to pass on the abstract question of whether the use of this particular machine under any circumstances would be illegal and would be prohibited by the court. The issue here is whether or not the treament accorded to the defendant, Meyer, between the 14th of November and the 21st of November at the hands of the officers of the law having him in charge was illegal and improper, and whether it should be permanently restrained." See Report No. 11 of the National Commission on Law Observance and Enforcement: Lawlessness in Law Enforcement (1931) 151, 152.

[31]People v. Gardner (1894) 144 N.Y. 119, 38 N.E. 1003, 28 L. R. A. 699.

[32]State v. Prodhomme (1873) 25 La. Ann. 522.

[33]Biggs v. State (1929) 201 Ind. 200, 167 N. E. 129, 64 A. L. R. 1085.

purpose;[34] to submit to a physical examination for scars or wounds;[35] to exhibit certain tattoo marks to the jury.[36] "Lie-detector" evidence is of a nature similar to that used in the foregoing cases. The instrument merely records the reactions in a subject's blood pressure and respiration when asked questions pertinent to the crime under investigation. (The record is precisely the same even though the subject remains silent instead of replying by the usual "yes" or "no.")[37] Therefore, in view of the fact (1) that lay testimony is admissible concerning the physiological and psychological reactions of a person accused of or while being tried for a criminal offense,[38] and (2) that compulsory submission to a "lie-detector" test does not provoke "compulsory testimony" (assuming, of course, the validity of the analogy to the decisions mentioned above), it would seem that an accused individual may be forced to submit to the examination. The evidence thus obtained could be presented to a court by either (or both) of two methods. A qualified expert might testify as to the recorded reactions and his interpretation thereof, or else the polygraph record could be presented to the court with merely an explanation by the expert as to what physiological changes, if any, occurred during the interrogation.[39]

At the present time no one is compelled to submit to the Polygraph test. Consequently, if the art of detecting deception by this method is recognized, evidence obtained as the result of a voluntary submission would not in any way violate the defendant's constitutional privilege, and therefore would be admissible in court.

The foregoing discussion concerning the constitutionality of "lie detector" evidence assumes, for this purpose, judicial recognition of the science as such. That, of course, is the first step. And eventually data and information concerning the high degree of accuracy of the most advanced method for detecting deception will be presented to the courts for their consideration in determining its judicial status as evidence of guilt or innocence. For that reason, consideration was here given to the possible methods by which a court could admit the evidence without violating the constitutional safeguard against self-incrimination, and also without prejudicing the cause of the prosecution.

B. The "Truth-serum":

The possibility of the existence of a "truth-serum" may be appreciated readily by anyone who has observed the frankness usually exhibted by an intoxicated individual.

Various drugs are capable of producing a mental state in which consciousness is more or less profoundly affected, thereby rendering a suspect's reactions somewhat automatic. In this condition a person is supposedly unable to survey critically his responses to questions, and as a consequence truth is forthcoming rather than deception.

Scopolamine and sodium amytal are the two drugs which thus far have been used in an effort to obtain scientifically from the suspected individual his own version of his participation in, or innocence of, the crime under investigation.

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[34]*People v. Sallow* (1917) 100 Misc. 447, 165 N. Y. Supp. 915.

[35]*O'Brien v. State* (1890) 125 Ind. 38, 25 N. E. 137, 9 L. R. A. 323.

[36]*State v. Ah Chuey* (1879) 14 Nev. 79, 33 Am. Rep. 530.

[37]In a recent murder case, the accused refused to reply to stimulus questions when tested on the "lie-detector." Despite this however, his specific reactions indicated his guilt. This was corroborated by other evidence including the confessions of two accessories who also had been subjected to the tests and later confessed their guilt as participants. The principal was sentenced to life imprisonment. See *State v. Miller* court records in New Philadelphia, Ohio.

[38]*Supra* notes 1 and 2.

[39]For practical and administrative reasons it seems more desirable to utilize the methods outlined above, rather than attempt to conduct the test in open court. The nature of the test is such that laboratory conditions are required for the best results. The confusion attendant to a court trial, the undue consumption of the tribunal's time, the undesirability of thus compelling an expert to make a hasty conclusion, constitutes some of the major reasons why the better practice would be to have the test administered before trial, and the results used only in the form of the opinion testimony of an expert reporting and interpreting them. See McCormick, *op. cit. supra* note 21 at p. 501.

Scopolamine, administered by subcutaneous injections, has been used frequently in obstetrical cases under the commonly known name of "twilight sleep." In fact, it was in such a case that its "truth-telling" effects were first noticed by Dr. R. E. House as possessing possibilities for use in criminal investigations.[40] Sodium amytal, administered intravenously, is another anaesthetic in general use in medical profession.[41]

The policeman with his "third degree" and the scientific investigator with his "truth-serum" are both working toward a common objective. Each recognizes the fact that in the mind of the suspect is locked the correct knowledge of the truth in every case. Both attempt to obtain the desired information by direct methods--by temporarily destroying in the brain the power of reason, imagination, and determination. But the officer of the law does it by brute force--with its attendant results of bodily injury, mental suffering, and not infrequently death itself; whereas the scientist uses nothing but a painless anaesthetic which leaves no disagreeable after effects, either mental or physical.

According to Dr. House, the successful use of scopolamine in criminology is based upon the fact that a feeble stimulus is capable of setting in operation nerve impulses which are extremely potent in their effect. A few injections of the drug will depress the cerebrum of the brain to such an extent that the stimulus of a question can go only to the hearing cells, from which an answer is automatically sent back, because the power of reason is inhibited more than the power of hearing.[42]

Up to the time of his death in 1930, Dr. House had conducted several hundred scopolamine experiments--in many of which he procured the release of accused and convicted individuals who were subsequently proved innocent[43]--and his very conservative estimate of success was fifty per cent accuracy. Dr. House's findings were presented before medical societies and criminological bodies, his services always being offered without cost. He worked diligently to interest others in carrying on similar research and to make them realize that scopolamine offered a new and valuable means of crime detection. He realized that his "truth-serum" was not absolutely accurate, as could hardly be expected because of the human element involved. And for that reason be suggested that although every suspect believed guilty by a prosecuting attorney should be compelled to submit to the test,

[40]While attending to a woman at childbirth, a Dr. R. E. House of Ferris, Texas, requested an attendant (in a private residence) to look for scales with which to weigh the newborn infant. The attendant replied that he did not know where they were. Immediately, the mother, while under the influence of scopolamine spoke up and gave the desired information—telling just where they could be found. This incident prompted Dr. House to experiment with scopolamine, in order to ascertain whether it possessed any possibilities for application in criminal investigations. House, "The Use of Scopolamine in Criminology," 2 *Am J. Police Sci.* 328 (1931), reprinted from the *Texas State Journal of Medicine* (Sept., 1922).

[41]Experiments have been conducted lately in order to determine the therapuetic value of sodium amytal in serious psychotic cases. The beneficial influences of long periods of sleep as produced by this drug have been considered responsible for some of the good results obtained in a few such cases of psychopathic individuals. See Lindemann, "Psychological Changes in Normal and Abnormal Individuals Under the Influence of Sodium Amytal," 11 *Am. Jour. Psychiatry* 1083 (1932). Dr. Lindemann noted that in the normal individuals tested they all experienced a "feeling of well-being and serenity, a desire to communicate, to be every person's good friend, a grateful appreciation for the kindness and goodness of the persons of their environment or willingness to speak about very personal problems usually not spoken of to strangers." *Ibid.*, p. 1086.

[42]The same principle accounts for the loss or partial loss of memory in old age. "In old age, the cortical cells of the cerebrum are inhibited in their functions because the dendrites, with their synapses, shrink. The cortical cells do not then readily transmit thought to their neighboring thought cells, to complete what is called memory. That is why old people apparently live in the past and do not remember recent events with ease. A similar condition will be found in the brain of a person under the influence of scopolamine, except that instead of shrinkage of the synapses there is a temporary contraction." House, *op. cit. supra* note 40 at p. 333.

[43]Larson, op. cit. supra note 16.

only such evidence obtained as could be positively corroborated should be used against him.[44]

At the Scientific Crime Detection Laboratory, scopolamine experiments have been conducted with fairly satisfactory results. One case in particular is worthy of special mention. The circumstances and evidence surrounding the death of a man failed to substantiate his common-law wife's theory of suicide. Suspicion was directed at both the wife and a person identified as her paramour. The latter was so insistent in professing his innocence of the crime that he consented to take a scopolamine test.[45] While under the influence of the drug the suspect insisted that he did not kill the deceased. But when asked what he did with the pistol after the deceased had been shot he declared that he threw it into a river. He also stated that he covered the body with branches. At this point the investigators were in a quandary, because obviously nothing like this could have taken place in the instant case (the body having been found in bed with a pistol at its side). For that reason the questions were repeated. The subject then answered that he hid the gun in a patch of heather in a town in Ontario, Canada. Concerning the present crime, however, he continued to express his innocence. When be regained consciousness the investigators--seeking an explanation for the unrelated details of perhaps another crime--reminded him about the time he covered a body with branches. Upon hearing this the man's face paled. Then someone suggested the murder in Ontario. At this point the suspect became convinced that all his past secrets had been divulged, and he agreed to confess to everything. He told how the husband in the instant case arrived home and found him there as an unwelcome guest; of the struggle between the two; and of *the wife* shooting her husband, without the paramour knowing of her intention to do this. The suspect then continued to confess his guilt regarding the two previous murders about which the investigators knew nothing at all prior to the test. A communication with Ontario authorities disclosed the fact that this particular individual was wanted there for the very murder he so unconsciously described while under the influence of scopolamine.[46]

One investigator has asserted that better results are obtainable with sodium amytal than with scopolamine, because of the constant and prolonged duration of the state of mind induced by sodium amytal.[47] But his research, confined to a limited number of cases of non-criminal nature, has not been verified as yet. While it may be true that another more effective "truth-telling" drug is available, the results thus far obtained in scopolamine cases are indeed very encouraging.[48]

Decisions

The only appellate court decision upon the subject, *State v. Hudson*,[49] involved the admissibility of a physician's testimony

[44]House, "Why truth Serum Should Be Made Legal," 42 *Medico-Legal Jour.* 138 (1925).

[45]The innocent person will readily submit to either scopolamine or the "lie-detector" tests, and ordinarily the guilty individual dares not refuse what he considers a useless test anyway, for fear of such refusal being interpreted as an admission of guilt.

[46]See Wigmore, *Principles of Judicial Proof* (1931) 610 for a discussion of scopolamine tests, and in particular for a quoted letter written to Professor Wigmore by a prosecuting attorney in Alabama who describes his use of scopolamme in the solution of a series of serious crimes in Birmingham, Alabama. Also see an article in an English Medical Journal, 215 *The Lancet* 990 (1928), discussing a case in Hawaii where a confession is supposed to have been obtained from a scopolamine subject who was subsequently proved innocent by virtue of another person's normal confession.

[47]Lorenz, "Criminal Confessions Under Narcosis," 31 *Wis. Med. J.* 245 (1932).

[48]The results of experimentation with scopolamine indicate that in experimental cases the drug produces truth-telling effects in practically every instance. In actual cases, however, positive results have been obtained in approximately fifty percent of the cases. Nevertheless, the fact that any results are obtainable warrants its use under any circumstances.

[49]289 S. W. 920 (Mo. 1926); See note in 12 *St. Louis L. Rev.* 215 (1927).

concerning evidence alleged to have been obtained from the accused himself while under the influence of a truth-serum," presumably scopolamine. The evidence was rejected.

A comparison should be made between the attitude of the Missouri court in this case and that found in the opinions of the federal court in the *Frye* case and of the Wisconsin court in the *Bohner* case. But by way of partial justification for the court's attitude in the instant case, as expressed in the following quotation, it should be noted that the Missouri court was not informed as to the nature of the "truth-serum," and the circumstances surrounding the procedure for its introduction were none too favorable for the admission of almost any scientific evidence, regardless of its reliability.

"It was sought to introduce in evidence the deposition of a doctor residing elsewhere, who testified to the effect that be had administered to the defendant what he termed a 'truth-telling serum,' and that while under its influence the defendant had denied his guilt. Testimony of this character--barring the sufficient fact that it cannot be otherwise classified than as a self-serving declaration--is, in the present state of human knowledge, unworthy of serious consideration. We are not told from what well this serum is drawn or in what alembic its alleged truth-compelling powers are distilled. Its origin is as nebulous as its effect is uncertain. A belief in its potency, if it has any existence, is confined to the modern Caliostros, who still, as Balsamo did of old, cozen the credulous for a quid pro quo, by inducing them to believe in the magic powers of philters, potions and cures by faith. The trial court therefore, whether it assigned a reason for its action or not, ruled correctly in excluding this clap-trap from the consideration of the jury."[50]

Since the evidence obtainable by the use of a "truth-serum" is of testimonial nature, it would be inadmissible if the test were conducted without the defendant's consent. However, there should be no constitutional objection to its admissibility where the examination is made with full consent, and with knowledge of its nature and purpose. One writer has suggested that if it became generally accepted as a reliable eliminator of deception, the courts could, and would, admit "truth-serum" confessions obtained prior to trial, since after all it is the factor of unreliability that chiefly bars the forced confession under present conditions.[51]

C. Hypnotism:

The phenomenon of hypnotism, though frequently associated with occult practices, is recognized by psychologists as being nothing more than a state of heightened suggestiblity.[52]

Because of the fact that an individual in a hypnotic state will act according to instructions given him at the time, it has been thought possible to hypnotize a witness or an accused, instruct him to tell the truth and then question him concerning the crime under investigation. But since the art itself is based upon suggestibility, an interrogator would have to be extremely cautious of the manner in which he presents his questions, to avert the inherent danger of unintentionally falsifying the subject's narration. Moreover, the possibilities of hypnotism are limited to those persons susceptible to hypnotic influence.[53]

Decisions

Several attempts have been made to introduce evidence obtained through hypnotism, but in each instance the courts have rejected any such testimony. In a California

[50]289 S. W. .921.
[51]See McCormick, *op. cit. supra* note 21 at p. 502.
[52]Burtt, *Legal Psychology* (1931) 133.
[53]See Wigmore, *op. cit. supra* note 46 at p. 611.

case, *State v. Ebanks*,[54] the defendant, on trial for murder, called a witness supposed to be an expert hypnotist, who offered to testify that he had hypnotized the defendant and that under the hypnotic influence the defendant denied his guilt. The trial court refused to admit the testimony on the ground that this would be an "illegal defense," since the "law of the United States does not recognize hypnotism." The appellate court disposed of the case rather quickly by stating that "we shall not stop to argue the point, and only add the court was right."[55]

In a recent Canadian case, *Rex v. Booher*,[56] the Crown employed a hypnotist for the purpose of obtaining from the accused a confession concerning the murder for which he had been indicted. After several visits by the hypnotist, the defendant expressed a desire to confess and he did confess some time thereafter. Application was made by the Crown to admit the confession in evidence, but it was rejected on the ground that it may have been induced by the hypnotism, and therefore of an involuntary nature and consequently inadmissible.[57]

[54]117 Cal. 652, 49 Pac. 1049, 40 L. R. A. 269 (1898).

[55]It is interesting in this connection to note the language used in *State v. Exam,*. 138 N. C. 599, 50 S. E. 283 (1905), where the prosecution had asked the defendant's wife on cross-examination whether or not she had ever been hypnotized by her husband, whereupon the witness replied in the affirmative. Upon appeal this question was held to be a proper one, since it merely went to the purpose of affecting the credibility of the witness. The appellate court, however, this statement: "While this subject of hypnotism has received to some extent 'judicial recognition,' in the language of one of the briefs, the sources of its power and the extent of its influence, are in the main, unknown, and we must hesitate to enter on such a field in search of error. "

[56](1928) 4 D. L. R. 795.

[57]"In the principal case, where there was evidence that the accused might have been in a post-hypnotic state when making the confession, the court was doubtless correct in excluding the admission, as the authorities on hypnotism seem to agree that its use for such purpose is unreliable, as the subject can be made to say anything, and will often lie even under honest questioning." 17 *Cal. L. Rev.* 311, 312 (1929). See in this connection: Bannuster, "Hypnotic Influence in Criminal Cases," 51 *Albany L. J.* 87, 88 (1895). See note on this case, and also collection of citations to scientific publications concerning the reliability of hypnotism for this purpose: 42 *Harv. L. Rev.* 704 (1929).

The question as to the admissibility of confessions while asleep also has been before the courts. In *People v. Robinson*, 19 Cal. 41 (1861), the trial court permitted a witness to testify as to what the defendant had said in his sleep concerning the murder. This was held erroneous upon appeal: "If the defendant was asleep, the inference is that he was not conscious of what he was saying, and the words spoken by him in that condition constituted no evidence of guilt." *Ibid.* p. 42. A witness in *State v. Morgan*, 35 W. Va. 260, 13 S. E. 385 (1891), was permitted to testify that while the defendant was in bed (whether asleep or not the witness could not say) she exclaimed, "I only consented to his death, and they gave him the poison." The appellate court said that if the defendant were asleep at the time then the exclamation was useless.

A Conversation with Fred E. Inbau and John E. Reid: Origins of the Illinois Crime Lab

Gordon H. Barland

Abstract

Fred E. Inbau died on May 25, 1998, and John E. Reid on January 11, 1982, both after long and fascinating careers. On December 10, 1979, Dr. Gordon Barland recorded an interview with Fred E. Inbau and John E. Reid at the Reid College of Detection of Deception, 215 Dearborn, Chicago, Illinois. The total interview time was 2 hours and 45 minutes. The following are excerpted portions of that interview.

Keywords: crime lab, history, Fred E. Inbau, John E. Reid.

INBAU: The crime lab was sold to Chicago Police Department and I can come back with some of this for you because there were some interesting tidbits about it. But I was asked to come over as director for one year and I ended up staying there 3 years, and that was '38 to '41.

BARLAND: What brought you to the crime lab in the first place?

INBAU: Well, I received a fellowship in criminal law at Northwestern. I had graduated from Tulane University and there was this fellowship in criminal law and this was 1932 and it was $1500 which was big money in those days and a lot of people in law practice were not getting that kind of money. But it was a $1500 fellowship and I had to pay my tuition and then I had to sustain myself for the rest of the year. I decided to write my thesis on scientific evidence because the scientific crime detection laboratory was then part of the law school. Initially it started out as part of the law school.

BARLAND: Now as I recall the crime lab started following the Saint Valentine's Day Massacre, in what year was that?

INBAU: Right, that's what triggered it; that was 1929. Then Burt Masse of the Palmolive Peat Company and Olson of the Olson Rug Company put in some money but it was primarily Burt Masse who put in the money to start the lab. And then Dean Wigmore of the law school was interested, of course, in all of this and he arranged so that Goddard could have his office at the law school because of the microscopic equipment. That was before I came on the scene. Then there was money put up to expand so that they could have a staff, and Goddard assembled a staff and then it became, then it was officially part of the law school.

BARLAND: In what year was that about?

INBAU: That was in the latter part of '29 to '30. And he had a staff of about 6 people initially and while I was doing my graduate work since I wanted to write my thesis on scientific evidence. I had a masters in zoology when I was in college and I had a interest in things scientific, things of that nature. Not anything that had to do with physics or mathematics or I never would have come aboard. But I did have that interest and I decided in order write from the legal standpoint I wanted to know something about the techniques for arms identification, fingerprint identification, document examination then there was the polygraph department with Leonarde Keeler, who was the man in that department.

BARLAND: Well, when was Keeler brought in?

INBAU: Goddard brought him in I think it was, I can't tell you just exactly when, but it was in the 30's, the early 30's as I recall. He also brought in Charlie Wilson. These were my contacts at the crime lab. I used to just hang around there as an

observer, ask questions, and fiddle around with document examination; Leonarde Keeler's wife, Kate Keeler, was the document examiner. So I would tinker with some of that and look at some bullets so I could get an idea. Not that I wanted to be expert in any of these fields--but so that I could have some idea as to what it is all about. And indeed, a little later on I actually conducted some experiments on eye witness identification, handwriting compared with expert identification, but that is getting ahead of the story a bit. But in hanging around the laboratory the one area that fascinated me particularly was the polygraph, of course we called it the lie detector. The lie detector, that is what it was all about; it was an instrument. The part that was of particular interest to me was the interrogation aspects of it. So after observing this for that nine-months period, I stayed instead of going back to Louisiana, which was my intention, to go back there and practice law. Goddard was no longer director: he was on his way out when I came in there in 1932. So they invited me to join the staff.

BARLAND: Now, we are talking about '38 or '32?

INBAU: That's '33 now, I had just about finished my graduate work at the law school, and they invited me stay on as a member of the staff and assist Keeler with the polygraph. And in order to sustain me until September when there would be funds available to pay my salary. I ran an exhibit at the World's Fair, the space for which was donated to the University by the Fair management because they had some vacant space there and there was some money. I forget who put the money up, but they paid me to hang on for three months. So I stayed at the World's Fair at the exhibit in charge of it and we had all kinds of stuff set up there. We had the police department involved in it and they had a police car there with the radio transmitters and all that, and people were fascinated with the whole business we had exhibits out. I used to manage that operation during the day, and we had a couple police officers assigned there with them. Just answering questions people asked, and it was good advertising for both the University and the whole field, and people were being exposed to it who had never heard anything about it before. Well, when the summer was over, then I joined the staff full time and I working with Keeler doing the polygraph cases.

BARLAND: How did you receive your initial training?

INBAU: From Keeler.

BARLAND: On a tutorial basis?

INBAU: Yes.

BARLAND: At that time Keeler apparently had not started his school.

INBAU: Oh, no. His school came later on. In fact, I can lead into that a little later.

BARLAND: Let me ask one other question that relates to this period of time. To your knowledge, how many polygraph-trained people were there in the entire country at this time?

INBAU: Oh golly, actually John Larson out on the West coast, he was an MD, and he is the one who first started putting together the semblance of the polygraph. And then he actually put together an instrument and then later Keeler refined it. Incidentally, there was a breech created between the two because Larson felt that Keeler had more or less copied his instrument.

BARLAND: I thought the main difference was that Larson's was so big that it was on a laboratory table and couldn't move.

INBAU: Unwieldy at times.

BARLAND: And that Keeler had miniaturized and made it portable.

INBAU: That's right, but I do know for a fact that the two of them didn't get along very well after that.

BARLAND: In your own minds obviously we can trace the evolutionary beginnings way back, with the early doctors feeling pulses and so on. But in your minds, when you think of the beginning of the polygraph technique or the lie detection

techniques as we know it today, what do you consider to be the beginning?

INBAU: Of course, Marston with his systolic blood pressure technique using the stethoscope --I think the real beginning was when Larson put his stuff together.

BARLAND: Yes, that was in my mind, I date it with Larson.

BARLAND: Let me go back and pick up the question that we had just started getting into, and that is how many examiners were there in this period back in '32 to '33.

INBAU: To my knowledge outside of what Larson was doing there was just Keeler, and that was it. Charlie Wilson would dabble around, but Charlie was a shop man, and he loved to fool with machines, but he wasn't really a polygraph examiner. Charlie was out of his element when it came to fooling around with the polygraph. There would be very few cases he would run, so it was Keeler and I who were running the cases, and outside of that I don't know of anybody who was in the field.

BARLAND: And one other question before we take up the crime laboratory again: It was my understanding, I think it was in an article written by Goddard or one of the early pioneers that was just published in *Polygraph* a couple of years ago, that indicated that one of the main differences why there was animosity between Keeler and Larson was their personalities. Larson was methodological, scientific, precise, and Keeler was more intuitive, oriented on investigation, using the polygraph as an aid to investigation rather than as an end in itself. Do you have any comment on that?

INBAU: At that time what Keeler was using and what I was trained in was the relevant-irrelevant question process. And Keeler did have this intuition; he relied very heavily on that, although I think that it is fair to say that what he was doing was attributing it to the polygraph itself. I recall on one occasion his wife was showing somebody through the laboratory, and we had some exhibits on the wall--polygraph charts and cases--and confession of guilt, and someone asked her how accurate it is, and she said it's infallible. Well I called her aside later on and said, "Kate did I hear you correctly when you said it was infallible?" And she said, "Well, isn't it?" I said "No, it's not" and we let it go at that. But Keeler, I'm not all together convinced that he believed this himself. But his wife, at least, because of that viewpoint, there was only one place she could pick it up. The reason it prompted me to check his wife, on her statement, was because I had come across instances where you were let down by the instrument. But Keeler was a hell of a guy in interrogating somebody. He was exceptionally good at that.

BARLAND: As long as we are on the topic of Keeler, let's just skip ahead a little bit further. How did he die? I had heard that Keeler died in an automobile accident, then I also from Bob Musser that you had mentioned to him that he had died in a motorboat.

INBAU: Well a fishing boat, I don't know if it was a motorboat. I think there was Keeler and Charlie Wilson together fishing up there in Wisconsin, and that Charlie said that Keeler got himself a stroke, a massive stroke and died before he left the boat. That's where it actually happened.

BARLAND: This would have been in the summer of '48.

INBAU: He was 45 years old. Keeler had become a very frustrated man. First of all, his father named him Leonarde, after Leonardo De Vinci. I got this from Keeler himself. His father wanted him to do great things that that's why he gave him the name Leonarde De Vinci. So, here's a youngster who's supposed to do great things, and he would get a lot of recognition, but there was one thing that I think that was very damaging to him, siphoned off energy that could have been devoted other purposes, for instance, writing a book. He would be invited to parties and they would want him to bring the polygraph so he would be the life of the party, entertaining everybody at somebody else's party. And when he would get on a train and somebody would ask him what business he was in, he'd say "I'm in the lie detection business." Then he would be asked to talk all

about it. So, he may go from Chicago to Denver and he would be entertaining this fellow and anybody else that wanted to listen. Whenever I got on a train, and someone would ask what business I was in, I would say I'm a lawyer. I may have a polygraph right next to me, but I'd be damned if I was going to tell anybody about it. I told Keeler "Look, Leonarde, you should write a book about this and I'll help you on it." He said "No, I think I need to make an around the world trip to get away from everything, and then I can write a book." He would have liked to have been a doctor. So I suggested to him at the lab that I would handle the cases, let's say in the morning or the afternoon. Part of the day when he was off he could take courses and go to medical school. Then when I was off, I would be in the law library. He thought that sounded great, but it wasn't very long that he found it a little too rough going to medical school. He told me this arrangement doesn't work, and we've got to work here together. Then Keeler was invited to take a cruise in the Caribbean with Eugene MacDonald, Zenith Corporation. He had become acquainted with him, and MacDonald invited him to take this Caribbean cruise.

BARLAND: Was MacDonald the president of Zenith?

REID: Yes, he owned it.

INBAU: Well, that meant that I was going to run the polygraph tests while Keeler was gone, then make it up. Later on, he would take over and then I would take some time off. Up to this time, when people would call some of the banks and insurance companies, they would want to talk to Keeler and arrange for Keeler to run a test, not wanting me to handle it and I was his assistant. But while he was gone there were two big cases broken, one in Chicago. I got a confession from a fellow who had murdered a girl and thrown her body in the sewer. Then I went down to Peoria and ran the Jerry Thompson case and got a confession from him, and those cases got a lot of attention in the press. There is no questions in my mind that Keeler developed the feeling of jealousy. After all, this upstart is now getting recognition. After this summer when I was meeting with the excess of people who called up and then they started asking if I were available. In other words it didn't make any difference whether it was Keeler or Inbau at this point, what differences should it make? Our relationship became rather strained at that point, and this was about 1937, I guess it was '36 or '37. Then the University was short of funds and laboratory was a drain, even though we were charging banks and insurance companies for our services. But that still didn't take care of all the expenses. About 1937 or the early part of '38 the Chicago police department indicated interest in the crime lab, so a representative from the police department met with the dean of the law school. Two of them came over, John Hall and Mike McNorton, to talk to the dean. The dean was interested.

REID: That was Quigmore wasn't it?

INBAU: No, that was Greene at that time, Greene was the new dean. They said they would take Charlie Wilson as the director. The deal was that Charlie Wilson would become the director, now mind you that I had an appointment at the law school. I was going to go teaching over there. Well, Wilson came down with what was diagnosed as multiple sclerosis and he spent a lot of time up in Michigan, the whole summer. This put a kink in their plans. Then it was suggested I take over until Wilson recovered. The dean called me in and twisted my arm. I agreed to do it for one year. I didn't want to be director of the laboratory. Well, in any event, this completed the breech, and Keeler set up his own private laboratory and then started training.

REID: This was the first one.

INBAU: Yes, that was the first one, I think he trained (Leonard) Harrelson, and Harrelson later took it over. Charlie Wilson was really not in shape at the end of the year to take over directorship, so I was asked to stay another year. Charlie still wasn't up to it, and by the third year Charlie still wasn't fully up to it. In any event, he was making some recovery, and he began asking me when I was going leave. I told Charlie I was ready to leave anytime. I served notice that I was going to leave. I wanted to teach ultimately. I figured I had better get some law practice

under my belt, so I went into law practice in '41. That's when Charlie Wilson took over. The only reason that I went into law practice was so I could better prepared myself for teaching. As a matter of fact, I was in law practice only a short while when my mentor, the fellow who was responsible for my getting fellowship at Northwestern, was killed in an automobile accident. So, the dean called me on the phone and asked me to come on over for full professorship in law. I agreed. Of course, the war came along and that's another story. I had applied for commission in Naval Intelligence before the war started, but they lost my file somewhere. That's a story in itself.

Erratum

In Volume 29, issue 4 of *Polygraph*, an article appeared entitled Validity in the New Millennium by Dr. Stan Abrams. Two contributing authors, James Wygant and Glenda Leutwyler, were inadvertently left off the byline. Mr. Wygant is a private examiner in Portland, and Ms Leutwyler is the police polygraphist for Portland PD. Both teach at Western University School of Polygraphy.

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A summary of

Brenner, M., Branscomb, H. H., & Schwartz, G. E. (1979). Psychological stress evaluator – Two tests of a vocal measure. *Psychophysiology*, 16 (4), 351-357.

Sachiko Matsumoto

Investigators in the present study examined performance of the Psychological Stress Evaluator (PSE) in detecting deception and in reflecting nervousness and stress. The PSE is a commercially available vocal lie detector, and it captures inaudible changes in voice. Changes in the PSE recording are argued to be associated with stress, and the PSE has been used to find vocal changes that may reflect stress created by the attempt to deceive. Although the PSE has performed reasonably well in capturing vocal changes during non-deceptive tasks, a number of past studies have found the PSE to be unreliable in detecting deception. The PSE has been also criticized for its subjective scoring method and for the unreliability of scoring among judges regardless of their experience. Moreover, the quality of recoding has been found to influence the PSE scoring. Thus, despite the widespread use of the PSE, more research is needed to evaluate the PSE in the detection of deception.

Brenner, Branscomb and Schwartz (1979) tested the PSE in detecting deception (Experiment 1) and in reflecting nervous-ness and stress (Experiment 2). In Experiment 1, 20 participants were interrogated based on their personal information. The participants were instructed to deceive the interrogator on 5 questions. The participants were offered a cash reward for successful deception, and advised to produce emotional responses when being truthful in order to hide emotional responses on the 5 deceptive questions. Experiment 1 showed that the PSE did not perform better than chance levels in detecting deception, providing no support for the PSE in the detection of deception. In Experiment 2, 16 participants performed the mental mathematical task of a various difficulty level (i.e., easy to hard). The PSE recoding was used to capture vocal changes that might reflect nervousness and stress related to the difficulty of the mental mathematical task. Experiment 2 showed that PSE scores increased as the difficulty of the task increased. Furthermore, PSE scores mirrored error percentages and self-report nervousness scores such that the increase in PSE scores was related to the increase in errors and nervousness. More interestingly, PSE scores were found to reflect the task difficulty at the individual level. Out of 16 participants, 15 participants showed the increase in PSE scores with the increase in the task difficulty. One negative finding in Experiment 2 was that the PSE scores were influenced by response words. For example, the response word "5" led to higher scores than the response word "2." Thus, unlike Experiment 1, the PSE performed well in capturing vocal changed due to nervousness and stress related to the mental mathematical task.

Brenner at al. argue that the deception task in Experiment 1 might not produce high enough stress to see vocal changes, or that the PSE might be susceptible to the conscious attempt to produce emotional responses when being truthful. Also, the subjective scoring method might contribute to the failure of the PSE recoding to detect deception in Experiment 1. By contrast, the successful finding in Experiment 2 suggests that stress might indeed produce certain vocal changes that could be captured by the PSE. At the end, Brenner et al. emphasize the complexity of detecting deception that must be distinguished by changes due to other factors. Also, they advise that the PSE should be protected from the influence of the recording quality and the response-word.

A summary of

Cestaro, V. L., & Dollins, A. B. (1994). An analysis of voice responses for the detection of deception. (Report No. DoDPI94-R-0001). Fort McClellan, AL: Department of Defense Polygraph Institute.

Sachiko Matsumoto

There is some evidence that pitch and spectral energy patterns reflect emotional arousal and stress, and the present study examined pitch and spectral energy patterns of verbal responses that might be related to deception. In the present study, deceptive and truthful responses were recorded, analyzed and compared. Also, the standard polygraph instrument was used to make a comparison to the analysis of pitch and spectral energy patterns in the detection of deception.

A total of 44 participants were assigned to the deceptive group or the innocent group. All participants were given a matrix of numbers and had to complete an anagram for a particular number. The deceptive group completed an anagram for the number 64, and 80 to 89, and the innocent group completed an anagram for the number 84. After completing the anagram, the first examination session took place, and each participant had to answer a set of 7 questions about a number that might come from the anagram. There were 6 sets of 7 questions in the session, and a question was asked for each number from 60 to 66 (e.g., "Did you complete an anagram for the number 60?"). The deceptive group had to make a deceptive response about the number 64, and the innocent group responded "no" to all the 7 questions truthfully. All verbal responses were recorded for the voice analysis, and the standard polygraph instrument was used to collect date in skin resistance, respiration and cardiovascular activity. With the same procedure, the second examination session took place 5 days after the first session.

Pitch patterns showed no particular indication of deception. Using data from pitch patterns, the accuracy rate in the detection of deception was 37%, and it was not different from the chance level accuracy. By contrast, using the standard polygraph instrument, the accuracy rate in the detection of deception was 79%, and it was significantly higher than the accuracy rate using the pitch pattern analysis. Similarly to results of the pitch pattern analysis, no particular spectral energy patterns were related to deception. Thus, it appears that in the present study, pitch and spectral energy patterns did not show any particular change associated with the act of deception. It is possible that one deceptive response was not enough time to induce change in voice, and it might be interesting to examine the possibility of delayed change by requiring more than one response for a question.

A summary of

Cestaro, V. L. (1995). A Comparison Between Decision Accuracy Rates Obtained Using the Polygraph Instrument and the Computer Voice Stress Analyzer (CVSA). (Report No. DoDPI95-R-0002). Fort McClellan, AL: Department of Defense Polygraph Institute.

Sachiko Matsumoto

Cestaro (1995) tested the computer voice stress analyzer (CVSA) for its theoretical claim to identify the change of microtremors (i.e., wavering) in speech signals and its ability to detect changes in voice that might be related to deception. The CVSA is designed according to the theory that an increase in stress leads to a decrease in the magnitude of wavering in voice. So, assuming that deception causes stress and that stress indeed decreases the magnitude of wavering in voice, the CVSA is to identify the change of wavering in voice and could provide information whether or not a given individual is being truthful.

In the first experiment, stressed and unstressed voice responses were simulated by laboratory function generators, and the CVSA was tested for its ability to identify the change of wavering in speech signals. It was found that the CVSA outputs correctly indicated changes of wavering in speech signals, supporting the theoretical basis for the CVSA.

In the second experiment, Cestaro (1995) investigated whether or not the CVSA detects deception based on stressed-changes in voice. To do so, the accuracy of the CVSA was compared to the accuracy of the traditional polygraph method in the detection of deception. A total of 42 people participated in the experiment. They selected a number between 3 and 8. Then, in the questioning phase, they were instructed to lie about the number they chosen. Participants' responses were recorded for the CVSA, and the traditional polygraph instrument recorded changes in skin resistance, respiratory and cardio-vascular activity. The main interest was whether or not the CVSA and/or the traditional polygraph method would provide information to identify the number that the participants selected. Four trained CVSA judges evaluated data from the CVSA, and four trained polygraph judges evaluated data from the traditional polygraph method.

The CVSA produced the overall accuracy of 38.7%, and it was not different from chance. By contrast, the traditional polygraph method produced the overall accuracy of 62.5%, and it was significantly better than chance. Thus, although the theoretical basis for the CVSA appeared to be valid, the actual performance of the CVSA in the detection of deception was not different than chance. Also, the CVSA was less accurate than the traditional polygraph method. It is possible that the experiment did not produce enough stress for the CVSA to detect any sign of deception. It might be useful to use the CVSA in conjunction with other methods to enhance the accuracy in the detection of deception.

A summary of

Cestaro, V. L. (1996). A comparison of accuracy rates between detection of deception examinations using the polygraph and the computer voice stress analyzer in a mock crime scenario. (Report No. DoDPI95-R-0004). Fort McClellan, AL: Department of Defense Polygraph Institute.

Sachiko Matsumoto

The present study made a comparison between the standard polygraph instrument and the computer voice stress analyzer (CVSA) in the detection of deception. A standard polygraph instrument examines changes in skin resistance, respiratory and cardiovascular activity to identify the act of deception. The CVSA is designed to identify the change of wavering in voice that could be related to the act of deception. Cestaro (1996) tested the standard polygraph instrument and the CVSA for identifying participants who provided deceptive responses after committing a mock crime.

A total of 120 people participated in the study. Half of them were assigned to the guilty group, and the other half were assigned to the innocent group. Participants in the guilty group were instructed to take $50 from a wallet in a wall locker, and then to deceive the examiner about taking the money in the interview. They were told that they could keep the money if they succeeded in deception, but they would lose the money if they failed in deception. Participants in the innocent group were given information about the crime, but did not participant in the mock crime. Half of participants from the guilty group and the innocent group took the interview with the standard polygraph instrument, and the other half took the interview with the CVSA. The polygraph results were judged by 2 administering examiners who conduced the interview and 3 blind evaluators, and the CVSA results were also judged by 2 administering examiners and 3 blind evaluators.

For the standard polygraph instrument, an overall accuracy rate was 57.2%, and for the CVSA, it was 52.2%. Neither 57.2% nor 52.2% significantly differed from the chance level accuracy of 50.0%. When the degree of agreement among examiners and evaluators was examined, it was higher than the chance level. For the standard polygraph instrument, examiners and evaluators agreed on 60% of the decisions, and for the CVSA, they agreed on 52% of the decisions. Therefore, it appears that the low accuracy rate in the detection of deception was due to the low sensitivity of a method rather than any particular characteristics about examiners or evaluators. It is probable that the mock crime scenario in the present study was not stressful enough to cause identifiable physiological changes. More research is needed to learn more about the amount of stress required for an instrument to detect the act of deception.

A summary of

DoDPI Research Division Staff, Meyerhoff, J. L., Saviolakis, G. A., Koening, M. L., & Yurick, D. L. (2001). Physiological and biochemical measures of stress compared to voice stress analysis using the computer voice stress analyzer (CVSA). (Report No. DoDPI01-R-0001). Fort Jackson, SC: Department of Defense Polygraph Institute, & Washington, DC: Walter Reed Army Institute of Research.

Sachiko Matsumoto

The present study investigated the computer voice stress analyzer (CVSA) for its ability to identify stress-related changes in voice. Also, investigators compared voice changes indicated by the CVSA to other physiological changes (i.e., heart rate, blood pressure and stress-related hormones) in order to examine any corresponding changes between voice changes and other physiological changes. Previous study results have been inconclusive as to the reliability and validity of instruments that claim to identify stress-related voice changes. By contrast, previous studies have indicated that stress is related to increases in heart rate, blood pressure and stress-related hormones. Thus, if the CVSA indeed identifies stress-related changes in voice, those voice changes should parallel stress-related changes in heart rate, blood pressure and stress-related hormones.

Twenty-two soldiers at the Walter Reed Army Institute of Research participated in the present study. They appeared before the panel of higher-ranking officers, and took the practice interview. The interview was conducted individually, and each participant answered questions regarding career experiences and goals. Before, during and after the interview, physiological changes were measured, and vocal responses were recorded for the CVSA. Three judges who were blind to the study design examined CVSA outputs and gave numerical stress scores to CVSA outputs.

During the interview, heart rate, blood pressure and stress-related hormones showed increases, as compared to before and after the interview. By contrast, there was no change in stress scores based on the interpretation of CVSA outputs. Further-more, there was little agreement in stress scores among the three judges. Thus, although heart rate, blood pressure and stress-related hormones showed stress-related changes, the present study provided no evidence to support the CVSA for its ability to identify stress-related changes in voice. More research is recommended to obtain conclusive evidence about the reliability and validity of voice stress instruments in detecting stress and deception.

A summary of

Horvath, F. (1979). Effect of different motivational instructions on detection of deception with the Psychological Stress Evaluator and the galvanic skin response. *Journal of Applied Psychology, 64,* 323-330.

Sachiko Matsumoto

Effects of motivation and strategy on the Psychological Stress Evaluator (PSE) were examined in the detection of deception. The PSE is designed to capture imperceptible changes in voice that occur as a result of stress. The PSE processes taped-recording of vocal responses, and creates a display of vocal changes related to stress. Evidence for the validity of the PSE is very mixed, and some researchers have suggested that the PSE is not sensitive to a low level of stress. Although the PSE and other polygraph measures are based on physiological data, a low level of motivation and an intentional strategy could make it more difficult to detect the act of deception. So, the present study examined effects of motivation and strategy in the detection of deception. As a comparison to the PSE, the galvanic skin response (GSR) was also collected.

To examine the effect of motivation, participants in the present study were told that they would receive a credit toward their class only if they succeed in the assigned task (i.e., high motivation). Then, the GSR data in the present study were compared to GSR data from Horvath (1978) who simply instructed his participants that they would receive a credit at the completion of the experiment (i.e., low motivation). Then, to examine the effect of strategy, a total of 64 participants were assigned to the "be-detected" condition or the "avoid-detection" condition. Although all participants had to produce "no" responses, the goal in the "be-detected" condition was to have the examiner detect a deceptive response, while the goal in the "avoid-detection" condition was to keep the examiner from detecting a deceptive response. The PSE and GSR data were collected in both conditions. In the study, participants chose a number from a set of 5 numbers. In two interview trials, they were to respond "no" to all questions regarding any numbers, including the one they chose.

Two trained examiners evaluated the PSE outputs and the GSR data, and an additional independent examiner evaluated the GSR data. The accuracy rate based on the PSE was not better than the chance level of 20%. It was 19.5% for the first trial, and 17.2% for the second trial. The detection rate was higher in the "avoid-detection" condition than in the "be-detected" condition. By contrast, the accuracy rate based on the GSR was better than the chance level. It was 52.3% for the first trial, and 50.8% for the second trial. There was no clear effect of strategy, but the detection rate tended to be higher in the "be-detected" condition than in the "avoid-detection" condition. A comparison to Horvath (1978) revealed that a higher level of motivation led to a greater rate of GSRs. Thus, the PSE did not perform better than what was expected by chance, nor did it perform as well as the GSR. A higher level of motivation led to a greater rate of GSRs, but the type of strategy showed a different pattern of effects between the PSE and the GSR.

A summary of

Horvath, F. (1982). Detecting deception: The promise and the reality of voice stress analysis. *Journal of Forensic Sciences*, 2, 340-351.

Sachiko Matsumoto

Horvath (1982) evaluates the voice stress analysis method in the detection of deception. He reviews research studies that examined the reliability and validity of voice analysis devices, such as the Psychological Stress Evaluator. Horvath's paper is organized with the following sub-categories, and the present summary will follow his organization: the microtremor theory, the detection of stress, the detection of deception in laboratory studies, objections to laboratory studies, and the detection of deception in field studies.

The PSE and other voice analysis devices are designed to capture voice changes that may be related to stress in the act of deception. The voice stress analysis is based on the theory that there is an inverse relation between stress and the frequency modulation in human voice, and that voice analysis devices are capable of detecting imperceptible changes in the frequency modulation. Some studies directly examined the theory and assumption of the voice stress analysis, and provided no evidence that there is a specific relation between stress and the frequency modulation, or that stress actually contributes to changes in the frequency modulation.

Voice analysis devices have also been tested whether or not they could actually measure the level of stress. Although voice analysis devices were able to detect stress under limited conditions, the performance was not consistent, and overall results did not provide convincing evidence. Furthermore, many laboratory studies have been conduced to examine the performance of voice analysis devices in the detection of deception. The laboratory studies consistently showed that the standard polygraph method performed better than the voice stress analysis, and that the voice stress analysis did not perform better than the chance level. Although evidence from the laboratory studies is strong, it is not free of objections. The main objection to laboratory studies is that they do not create a real sense of jeopardy, and consequently, not enough stress is created for the voice stress analysis to function optimally. To defy the objection, the voice stress analysis has been tested in a field setting, and compared to the standard polygraph method. Like laboratory studies, it was found that the voice stress analysis did not perform better than the chance level. Moreover, the comparison to the standard polygraph method revealed that there was no reliable correlation between the voice stress analysis and the standard polygraph method. Thus, Horvath (1982) argues that there is no evidence that the voice stress analysis actually provides any information about stress or the act of deception.

A summary of

Horvath, F. (1978). An experimental comparison of the Psychological Stress Evaluator and the galvanic skin response in detection of deception. *Journal of Applied Psychology*, 63, 338-344.

Sachiko Matsumoto

The validity of the Psychological Stress Evaluator (PSE) was tested in the detection of deception. The PSE is designed to capture imperceptible changes in voice that occur as a result of stress. The PSE processes taped-recording of vocal responses, and creates a display of vocal changes related to stress. Although the manufacture claims that the PSE is as accurate as the traditional polygraph method, evidence for the validity of the PSE is very mixed. In the present study, the PSE was tested and compared to the galvanic skin response (GSR) in the detection of deception. Also, the investigator examined the possible effect of wearing the blood pressure cuff on the accuracy of the PSE and the GSR, and the effect of the first trial vs. the second trial.

A total of 60 participants were assigned to one of the following 3 conditions: the tape-only condition, the tape-and-cuff with no inflation condition, and the tape-and-inflated-cuff condition. In the tape-only condition, only tape-recording was made for the PSE. In the tape-and-cuff with no inflation condition, participants wore the blood pressure cuff, but it was not inflated. In the tape-and-inflated-cuff condition, participants wore the blood pressure cuff, and it was inflated to measure the blood pressure. In all 3 conditions, tape-recording was made for the PSE, and in the tape-and-cuff with no inflation condition and the tape-and-inflated-cuff condition, the GSR was collected. In the study, participants chose a number from a set of 5 numbers. In an interview, they were to respond "no" to all questions regarding any numbers, including the one they chose (e.g., "Did you pick card number 13?"). In the second trial, the same set of questions was used, but it was presented to the participant in the reversed order of the first trial.

Two trained examiners evaluated the PSE outputs and the GSR data, and an additional independent examiner evaluated the GSR data. The accuracy rate based on the PSE was not better than the chance level of 20%. It was 24.2% for the first trial, and 20.8% for the second trial. There was no effect of the blood pressure cuff or the trial in the PSE data. By contrast, the accuracy rate based on the GSR was better than the chance level. It was 68.8% for the first trial, and 42.5% for the second trial. Furthermore, there was evidence for the effect of the blood pressure cuff and the trial sequence in the GSR data. A higher level of efficiency was found when the cuff was not inflated than when the cuff was inflated, and it was also true for the first trial than the second trial. Thus, the PSE did not produce the accuracy rate better than the chance level, and it did not respond to factors such as the presence of the cuff and the trial sequence. It might be the case that the present study did not create a sufficient amount of stress required for the PSE to produce reliable data. It would be crucial to determine a level of stress required for the PSE to maximize its accuracy rate.

A summary of

Janniro, M. J., & Cestaro, V. L. (1996). Effectiveness of detection of deception examinations using the computer voice stress analyzer. (Report No. DoDPI96-R-0005). Fort McClellan, AL: Department of Defense Polygraph Institute.

Sachiko Matsumoto

Janniro and Cestaro (1996) investigated the utility of the Computer Voice Stress Analyzer (CVSA) in the detection of deception. The CVSA is designed to identify stress-related changes in voice (i.e., "subaudible microtremors"), and it is argued that the CVSA should capture voice changes due to stress related to deception. Outputs of the CVSA are examined and judged by a trained examiner whether or not a particular individual is being truthful. Evidence from previous studies is mixed and inconclusive, and the present study examined the utility of the CVSA in the detection of deception.

A total of 109 participants were assigned to the deceptive group or the non-deceptive group. A participant in the deceptive group was instructed to take $100 from a box in a scenario room and then to hid $100 on him or her, while a participant in the non-deceptive group did not have to perform the theft. Then, in the questioning phase, a participant in the deceptive group was told to lie about taking and hiding $100. A participant in the non-deceptive group responded truthfully.

Based on the comparison between critical responses (ones that the deceptive group had to lie about) and control responses, trained examiners judged whether or not a particular individual is being truthful. The overall accuracy was 49.8%, and it was not different from the chance level. Moreover, no examiner did better than the chance level. Although the consistency of judgment among examiners was found, the CVSA failed to provide sufficient information in the detection of deception.

A summary of

Kubis, J. F. (1973). Comparison of voice analysis and polygraph as lie detection procedures (Contract DAD05-72-C-0217). U.S. Army Land Warfare Laboratory, Aberdeen Proving Ground, M.D.

Sachiko Matsumoto

Kubis (1973) examined the Psychological Stress Evaluator (PSE) and the Voice Stress Analyzer (VSA) in the detection of deception. Both the PSE and the VSA are designed as a lie detector based on the theoretical assumption that the act of deception creates stress, and that stress leads to changes in human voice. Voice analysis devices are supposed to detect the changes in voice that may be related to stress in the act of deception. Kubis (1973) conducted a study using a mock crime paradigm, in which participants served as a thief, a lookout or an innocent bystander, and the PSE, the VSA and the standard polygraph method were used to identify the role that a given participant played.

A total of 174 participants were assigned to play a role of the thief, the look-out or the innocent bystander. Participants who played a thief were told to enter a room and steal $21 from a bag in the room. Participants who played a lookout were asked to help the thief by making sure that no one would see the thief stealing the money. Participants who played a bystander were simply informed that an incident of the theft occurred. Moreover, thieves and lookouts were instructed to lie about any questions regarding their involvement in the theft, while bystanders answered all questions truthfully.

The standard polygraph method produced the overall accuracy of 52% to 76% in the identification of roles that participants played. In all cases, the accuracy by the standard polygraph method was better than the chance level of 33%. By contrast, the PSE showed the overall accuracy of 32% to 38%, and none was better than the chance level. Similar results were found for the VSA. The overall accuracy was 34% to 43%, and did not exceed the chance level accuracy. Thus, not only did the voice stress analysis perform worse than the standard polygraph method, but also the voice stress analysis did not exceed the chance level. The present study provided no evidence to support the validity of the voice stress analysis in the detection of deception.

A summary of

Long, G. T., & Krall, V. L. (1990). The measurement of stress by voice analysis. *Journal of social behavior and personality, 5(6), 723-731.*

Sachiko Matsumoto

Long and Krall (1990) tested the Mark II Voice Stress Analyzer as an indicator of stress caused by the exposure to an aversive stimulus. Like the Psychological Stress Evaluator (PSE), the Mark II is devised to capture changes in voice (i.e., "wavering") that may be related to stress. Unlike the PSE that is criticized for its subjective data interpretation process, the Mark II provides a numerical output and does not leave much room for a subjective interpretation of data. Although there have not been many studies, the Mark II was found to identify voice changes that were related to stress in a planned lie and anxiety.

In the present study, the Mark II was used to identify voice changes due to stress of being exposed to an aversive stimulus, a tarantula. A total of 38 participants (20 males and 18 females) were asked to say 3 words ("sleep," "lake" and "glass") first in the non-stressful condition, and then in the stressful condition. First, in the non-stressful condition, a participant simply said and made voice-recording of the 3 words, and gave a self-reported stress level, ranging from 0 (no stress) to 5 (very high stress). Then, a tarantula in a box was introduced, and the participant was told that he or she would have to touch the tarantula after making voice-recording, although in reality, the participant did not have to touch the tarantula. Having the tarantula in sight, the participant said and made voice-recording of the 3 words, and gave a self-reported stress level. The Mark II produced a numerical output (i.e., a stress score) for each voice-recording, that could range from 0 to 999, where higher scores reflected higher stress levels.

Stress scores were analyzed as a function of stress condition, gender and words. Overall, higher stress scores were found in the stressful condition than in the non-stressful condition, indicating that the Mark II captured voice changes related to stress. Also, higher levels of self-reported stress were found in the stressful condition than in the non-stressful condition. So, the finding by the Mark II was consistent with the finding in self-reported stress. Higher stress scores were found in females than in males, and more importantly, females showed a larger magnitude of voice changes due to stress than males. Moreover, the data analysis showed that the largest magnitude of voice changes was found on the first word (i.e., "sleep"), and the smallest magnitude of voice changes was found on the last word ("glass"). In other words, the word order influenced the magnitude of voice changes due to stress.

The present study provided evidence that the Mark II could identify stress-related changes in voice. However, there are some precautions that should be taken into consideration. First, the volume of voice influences the Mark II scoring: an increase in the volume leads to an increase in scoring. Characteristics of words also influence the Mark II scoring: elongated words lead to higher scores. Also, the Mark II is susceptible to individual differences. Consequently, the comparison has to be made in the same person between a non-stressful condition and a stressful condition, rather than between people in the non-stressful condition and people in the stressful condition. More research is needed to enhance the reliability and validity of the Mark II.

A summary of

Lynch, B. E., & Henry, D. R. (1979). A validity study of the Psychological Stress Evaluator. *Canadian Journal of Behavioral Science*, 11 (1), 89-94.

Sachiko Matsumoto

Investigators in the present study examined the Psychological Stress Evaluator (PSE) for its ability to measure arousal in vocal responses. The PSE is designed to capture inaudible changes (i.e., micro-tremors) in voice that may be associated with physiological arousal and stress. For the PSE analysis, verbal responses are recorded, and outputs from the PSE are scored by trained judges. Evidence for the validity of the PSE has been mixed, and the present study tested the PSE if it actually detects arousal in verbal responses, and if the PSE outputs could be indeed better scored by trained judges than untrained judges.

A total of 43 participants were asked to say 10 taboo words and 10 neutral words in a randomly order. It was hypothesized that taboo words would produce more arousal than neutral words, and the PSE should be able to detect arousal in verbal responses. Participants' verbal responses were tape-recorded for the PSE, and 2 trained judges and 10 untrained judges evaluated the PSE outputs. The judges made a decision whether or not a given verbal response was a taboo word or a neutral word. In addition to verbal responses, participants rated word stimuli on a 7-point scale, from very pleasant to very disgusting.

Although participants rated taboo words as more disgusting than neutral words, both trained and untrained judges failed to correctly identity taboo words and neutral words based on the PSE outputs. The accuracy of judgment based on the PSE was not different from chance. Thus, the PSE was not able to detect arousal in verbal responses to taboo words, and it appears that training did not contribute to a higher accuracy rate. It is possible that the level of arousal in the present study was too low for the PSE to detect. If a certain level of arousal or stress is required for the PSE to perform successfully, it is crucial to identify and quantify a lowest level of arousal or stress necessary for the PSE. More research is needed to understand the reliability of the PSE across various conditions of arousal and stress.

A summary of

Nachshon, I., & Feldman, B. (1980). Vocal indices of psychological stress: A validation study of the Psychological Stress Evaluator. *Journal of Police Science and Administration*, 8, 40-53.

Sachiko Matsumoto

The present study examined the reliability and validity of the Psychological Stress Evaluator (PSE) in the detection of deception. The PSE is designed to capture changes in voice that may be related to stress in the act of deception. Evidence for the PSE in the detection of deception is mixed, and it is not clear whether or not the PSE actually provides information that is useful to detect the act of deception. In the present study, the reliability and validity of the PSE were investigated in a laboratory setting and a field setting. The reliability was measured as the consistency in judgments among PSE evaluators, and the validity was measured as the accuracy in detecting deceptive responses based on PSE evaluations. Also, the effect of arousal levels on the PSE was examined.

In a laboratory study, 20 participants were asked to make deceptive responses in the card test (i.e., low arousal) and the horror picture test (i.e., high arousal test). In the card test, participants chose a number card, and they had to respond, "No, I did not chose this card" to all questions about number cards, including the one they chose. Based on the PSE data, the evaluators judged what number a given participant chose. In the horror picture test, participants saw 26 pictures, including 9 pictures of victims from road accidents. Participants had to respond, "Yes, I like this picture" to all pictures. The PSE evaluators judged which responses were made to the 9 unpleasant pictures of victims from road accidents. In the card test, the reliability was lower than 30 %, and the validity was not better than chance. In the horror picture test, the reliability was about 60 %, but the validity was not better than chance. So, although the arousal level increased the reliability, the accuracy in either test did not exceed the chance level.

In a field study, 56 criminal suspects participated in the card test and in the interrogation interview. In the interrogation interview, they answered questions that were related or unrelated to a crime that they might have committed. The card test was the same as the laboratory study, and in the interrogation interview, the PSE evaluators judged if deceptive responses were made to questions related to the crime or unrelated to the crime. In the card test and in the interrogation interview, the reliability was about 50 % on average. Neither in the card test nor in the interrogation interview, was the validity better than chance. Thus, both the laboratory study and the field study provided no support for the validity of the PSE in the detection of deception.

A summary of

Nachshon, I. Elaad, E., & Amsel, T. (1985). The validity of the Psychological Stress Evaluator. *Journal of Police Science and Administration*, 13, 275-282.

Sachiko Matsumoto

The PSE is designed to capture changes in voice that may be related to stress in the act of deception. Evidence for the PSE in the detection of deception is mixed, and it is not clear whether or not the PSE actually provides information that is useful to detect the act of deception. Particularly, in controlled laboratory studies, the PSE has not received much support, and many laboratory studies provided negative results regarding the validity of the PSE in the detection of deception. However, laboratory studies are criticized for an unrealistic setting and a lack of stress for the PSE to detect. The present study was, therefore, conducted in a field setting with real criminal suspects. In the study, the PSE was compared to other polygraph methods, and the consistency between the PSE and other polygraph methods was examined.

A total of 40 criminal suspects were individually interrogated. In an interrogation, galvanic skin responses (GSR), respiratory activities and cardiovascular responses were measured and recorded. All verbal responses were recorded for the PSE evaluation. A blind procedure was used for all polygraph and PSE evaluations, and evaluators had no knowledge whether or not responses were made to crime-related questions or control questions. Responses were evaluated as pairs of a crime-related question and its control question, and evaluators were to decide which response in a pair showed more stress. Then, a given suspect was identified as a deceiver if crime-related responses showed more stress than control questions.

First, PSE evaluations of response pairs were compared to polygraph evaluations. Correspondence scores between PSE evaluations and polygraph evaluations raged from 33% to 55%, but they did not exceed the chance level. When PSE evaluations were compared to polygraph evaluations for the correspondence of final decisions (i.e., a deceiver vs. a truth-teller), PSE evaluations and polygraph evaluations agreed on deceiver decisions for 8.82%, and they agreed on truth-teller decisions for 64.71%. Thus, the present study showed that there were some degree of consistency between the PSE and other polygraph methods. However, some correspondence scores still did not exceed the chance level.

A summary of

O'Hair, D., Cody, M. J., & Behnke, R. R. (1985). Communication apprehension and vocal stress as indices of deception. The Western Journal of Speech Communication, 49, 286-300.

Sachiko Matsumoto

O'Hair, Cody and Behnke (1985) evaluated the Mark II Voice Stress Analyzer as an indicator of stress in making a deceptive response. The Mark II is designed to capture changes in voice (i.e., "wavering") that may be related to stress, and it provides a numerical score to indicate a level of stress. The present study employed a mock job interview setting, and the Mark II was tested in three types of deception: prepared lies, spontaneous lies, and delayed interrogative lies. For each participant, deceptive responses were compared to truthful responses for each of the three types of deception. Participants were assigned to a deceptive group or a truthful group. Participants in the deceptive group made a deceptive response to a critical question and then a truthful response to a control question, while participants in the truthful group made a truthful response to all questions. Also, based on scores on the Personal Report of Communication Apprehension, participants in the deceptive group were divided into a high communication anxiety group and a low communication anxiety group to examine the ability of the Mark II to identify stress of varying anxiety levels.

The mock job interview took place individually. In the mock job interview, a participant answered a question about the most recent employer that the participant was prepared to lie about (i.e., a prepared lie). Then, the participant was asked about duties in the most recent job (i.e., a spontaneous lie). After the prepared lie and spontaneous lie, the participant was asked about the second most recent employer (i.e., a control question for the prepared lie), and then duties in the second most recent job (i.e., a control question for the spontaneous lie). About the second most recent job, the participant responded truthfully. Then, as the interview was about to end, the participant was asked about a typical day in the most recent job (i.e., a delayed interrogative lie), and then about a typical day in the second most recent job (i.e., a control question to the delayed interrogative lie). Again, a deceptive response was made about the most recent job, and a truthful response was made about the second most recent job. In other words, the participant lied about the most recent job and responded truthfully about the second most recent job. Then, deceptive responses were compared to truthful responses.

Based on stress scores generated by the Mark II, higher stress scores were found in prepared lies than in truthful responses for the high communication anxiety group, but no difference was found between spontaneous lies and truthful responses or between delayed interrogative lies and truthful responses. No difference was found between any lies and truthful responses for the low communication anxiety group. Thus, the Mark II succeeded in identifying voice changes due to stress in prepared lies among high communication anxiety participants. However, the Mark II failed to capture voice changes in spontaneous lies and delayed interrogative lies for high communication anxiety participants, or any changes for low communication anxiety participants. For truthful participants who never lied in the experiment, the Mark II showed no sign of stress, indicating that the Mark II would not falsely identify a truth-telling individual as a deceptive individual.

A summary of

O'Hair, D., Cody, M. J., Wang X., & Chao, E. Y. (1990). Vocal stress and deception detection among Chinese. Communication Quarterly, 38, 158-169.

Sachiko Matsumoto

O'Hair et al. (1990) examined the Mark II Voice Stress Analyzer in the detection of deception with Chinese immigrants. Like the Psychological Stress Evaluator (PSE), the Mark II is designed to capture changes in voice that may be related to stress. Unlike the PSE, it does not require manual scoring of data; instead, the Mark II provides a numerical score to indicate a stress level for each response.

A total of 61 Chinese immigrants participated in the present study for a mock job interview. They were given deception instructions or truth-telling instructions. Participants with deception instructions received the name of false employment, and they were told to fabricate information based on the false employment. Participants with truth-telling instructions answered all questions truthfully. All participants answered questions that required de-scriptive, narrative or emotional responses. The Mark II analyzed each response, and gave a stress score. The voice stress analysis showed that male liars exhibited a higher level of stress than female liars when providing the fabricated information about the name of false employment. Moreover, male liars' responses to prepared lies showed more stress than other responses. Thus, there is evidence that voice stress might be related to prepared lies, but it was true only for male liars. Further research is needed to confirm the validity of the voice stress analysis.

A summary of

O'Hair, D., & Cody, M. J. (1987). Gender and vocal stress differences during truthful and deceptive information sequences. *Human Relations*, 40, 1-14.

Sachiko Matsumoto

O'Hair and Cody (1987) evaluated the Mark II Voice Stress Analyzer as an indicator of stress in making a deceptive response. Like the Psychological Stress Evaluator (PSE), the Mark II is designed to capture changes in voice that may be related to stress, but it has some advantages over the PSE. The Mark II allows an objective analysis by providing a numerical score to indicate a stress level, while the PSE requires an individual examiner to judge the presence of stress in the output. Also, with the Mark II, the analysis of multiple-word responses is possible, while with the PSE, the analysis is limited to one-word responses. In the present study, O'Hair and Cody used the multiple-word response format, and tested the validity of the Mark II in detecting prepared lies and spontaneous lies in a mock job interview.

A total of 49 participants were assigned to a deceptive group or a truthful group. For each participant, deceptive responses were compared to truthful responses. Participants in the deceptive group made deceptive responses to critical questions and then truthful responses to control questions, while participants in the truthful group made truthful responses to all questions. The mock job interview took place individually, and participants in the deceptive group lied about the most recent job, and responded truthfully about the second most recent job. First, a participant answered a question about the most recent employer (i.e., a prepared lie), and then, the participant was asked about duties in the most recent job (i.e., a spontaneous lie). After the prepared lie and spontaneous lie, the participant was asked about the second most recent employer (i.e., a control question for the prepared lie), and then duties in the second most recent job (i.e., a control question for the spontaneous lie). Deceptive responses about the most recent job were compared to truthful responses about the second most recent job.

Based on stress scores generated by the Mark II, higher stress scores were found in prepared lies than in truthful responses, but no difference was found between spontaneous lies and truthful responses. Scores from male participants were com-pared to scores from female participants, and it was found that only female participants showed a significant difference between prepared lies and truthful responses. Thus, the Mark II succeeded in identifying voice changes due to stress in prepared lies, but not in spontaneous lies, and it appears that females show more stress than males in prepared lies.

A summary of

Podlesny, J. A., & Raskin, D. C. (1977). Physiological measure and the detection of deception. Psychological Bulletin, 84 (4), 782-799.

Sachiko Matsumoto

Podlesny and Raskin (1977) reviewed laboratory studies on the detection of deception that utilized physiological measures as ways to identify those who might try to be deceptive. Their review is summarized in five categories, and addresses the applicability of laboratory studies to real-life situations and the accuracy and reliability of various physiological measures in detecting deception. The five categories are: the deceptive context, general considerations, tests of deception, data analyses and physiological measures, and each category is summarized briefly here.

The deceptive context is described as "the total set of circumstances surrounding a subject's possible deception" (p. 783). In laboratory studies, the deceptive context has to be artificially created, and there are concerns as to how applicable the deceptive context in laboratory studies is to the deceptive context in real-life situations. Investigators have identified high stress levels, motivation to deceive and threat of punishment to be important components in creating the deceptive context. However, further research is needed to learn more about characteristics of the deceptive context so that laboratory settings would parallel real-life situations.

To detect deception is a very difficult task, and there are general considerations regarding the detection of deception. First, because no particular patterns of physiological measures (such as increase or decrease in the heart rate) clearly indicates deception, investigators must be able to dis-tinguish patterns indicating deception and similar patterns indicating non-deceptive cases. Similarly, besides deception, various extraneous variables (such as surprise and uncertainty) influence physiological measures, and make it difficult to distinguish physiological changes due to deception from physiological changes due to things other than deception. Therefore, controlling extraneous variables becomes crucial in the detection of deception.

In laboratory studies, various tests of deception have been created to examine deceptive responses and truthful responses. Such tests often include "critical items" and "control items," and ask participants to respond to items while they are attempting deception or while they are being truthful. Critical items are associated with deception, and control items are not associated with deception. So, the comparison of responses between critical items and control items could provide information about processes that occur in deceptive responses, but not in non-deceptive responses. Also, the compari-son between deceptive participants and non-deceptive participants could be used to examine changes that only deceptive participants may exhibit.

In analyzing physiological measures in the detection of deception, objective techniques would enhance the accuracy and reliability of physiological measures in both laboratory and real-life settings. The accuracy rate of detecting deception has been used; however, statistical analyses have not been applied to accuracy rate data or data from physiological measures. Although the practical importance of actually detecting deception should be emphasized, more objective evaluations and statistical analyses of data would benefit research in the detection of deception.

Investigators have tried to measure physiological changes associated with

deception in various ways: cardiovascular activities (e.g., blood pressure and heart rate), respiratory activities (e.g., inspiration expiration ratio), muscle activities, ocular activities (e.g., eye blink), changes in voice, etc. Some measures have shown patterns of changes associated with deception, and others have not yet shown conclusive patterns. For example, increased blood pressure was found to be associated with deception, while the inspiration expiration ratio did not show above-chance level accuracy under some circumstances. As to the use of changes in voice for the detection of deception, the electronic voice analysis has indicated that the greater voice intensity was associated with deception in a low band (100-250 Hz) of voice signals. There were no particular patterns found in a full band (100-6000 Hz) of voice signals that were associated with deception. Also, some investigators have argued that stress induces changes in the voice, and some studies provide evidence that changes occur in the voice due to stress and deception-related stress. However, more research is needed to provide conclusive evidence that stress would lead to particular changes in voice. At the end, Podlesny and Raskin (1977) argue that more research is needed to identify and establish reliable measures for the detection of deception.

A summary of

Shipp, T., & Izdebski, K. (1981). Current evidence for the existence of laryngeal macrotremor and mictrotremor. Journal of Forensic Sciences, 26, 501-505.

Sachiko Matsumoto

Shipp and Izdebski (1981) investigated vocal microtremors in order to test the assumption that the voice stress analysis captures changes of microtremors in laryngeal muscles. Deception-related stress was claimed to lead to changes in the pattern of microtremors, and the voice stress analysis was designed to capture those changes and provide information for the detection of deception.

First, to better understand the characteristics of tremors, Shipp and Izdebski (1981) examined a rate of observable tremors (i.e., macrotremors) in vocalization of professional singers and participants with a vocal disorder. They were asked to produce the vowel sound /a/ for a period of time (e.g., 7 to 12 seconds) at low, medium and high pitch. Professional singers showed a rate of macrotremors from 4.7 to 6.6 Hz, and participants with a vocal disorder showed a rate of macrotremors from 3 to 10 Hz. The rate of tremors was not affected by pitch. Thus, although the existence of macrotremors was confirmed, there was no effect of pitch and no group difference in the rate of macrotremors.

Then, to examine vocal micro-tremors, Shipp and Izdebski (1981) measured electrical activities from laryngeal muscles while the participant produced conversational speech or speech sound. According to the assumption in the voice stress analysis, microtremors were expected to appear in the pattern of electrical activities. However, no evidence for the existence of microtremors was found in electrical activities from laryngeal muscles. This finding raises a question about the claim that the voice stress analysis captures vocal microtremers in laryngeal muscles.

A summary of

Suzuki, A., Watanabe, S., Taheno, Y., Kosugi, T., & Kasuya, T. (1973). Possibility of detecting deception by voice analysis. Reports of the National Institute of Police Science, 26, 62-66.

Sachiko Matsumoto

The present study examined characteristics of voice pitch, intensity and duration that might be related to the act of deception. If the act of deception produces some involuntary changes in voice, there should be some differences between deceptive responses and non-deceptive responses. Suzuki et al. (1973) analyzed tape-recording of deceptive responses from 3 people who had been confirmed as guilty of criminal acts. Deceptive responses were compared to non-deceptive responses in the analysis of voice pitch, intensity and duration. Voice pitch and intensity showed no changes that distinguished deceptive responses from non-deceptive responses. The accuracy rate in the detection of deception was lower than the chance level for both pitch and intensity. For voice duration, deceptive responses showed longer duration than non-deceptive responses, but the difference was not statistically significant. Moreover, The accuracy rate did not exceed the chance level. Thus, it was concluded that there was no evidence that the voice analysis provides information to detect the act of deception.

A summary of

Timm, H. W. (1983). The efficacy of the Psychological Stress Evaluator in detecting deception. Journal of Police Science and Administration, 11, 62-68.

Sachiko Matsumoto

The validity of the Psychological Stress Evaluator (PSE) was tested in the detection of deception when the actual guilty or innocent decision could be made and when the level of perceived jeopardy was high. The PSE is designed to capture imperceptible changes in voice that occur as a result of stress. The PSE processes taped-recording of vocal responses, and creates a display of vocal changes that would be evaluated by a PSE analyst. Although the manufacture claims that the PSE is as accurate as the traditional polygraph method, evidence for the validity of the PSE is very mixed. In the present study, the PSE was tested in determining if a participant was actually guilty or innocent of smoking marijuana.

There were 6 participants in the study. Half of them were accused of smoking marijuana, and the other half were accused of other offenses. They were all facing university disciplinary action. The 3 participants who were accused of smoking marijuana were told that all changes against them would be dropped, if the PSE outcome indicated innocence or turned out to be inconclusive. The other 3 participants who were not accused of smoking marijuana were told that all charges against them would be dropped, if they took the PSE examination about an incident of smoking marijuana. The PSE examination took place in the present of a clinical psychologist, and the participants were asked questions about an actual marijuana incident, a fictitious marijuana incident that did not occur, and neutral questions. All responses were recorded for the PSE analysis, and evaluated by the trained PSE analyst.

The PSE analyst made only one correct decision for the 6 participants. Only one correct guilty decision was made for a participant who was accused of smoking marijuana. Other decisions included incorrect guilty and innocent decisions, and inconclusive decisions. Thus, although the level of perceived jeopardy was high in the present study, the PSE was not able to provide information to indicate the act of deception.

A summary of

Waln, R. F., & Downey, R. G. (1987). Voice stress analysis: Use of telephone recordings. Journal of Business and Psychology, 1, 379-389.

Sachiko Matsumoto

In the present study, the reliability of the Psychological Stress Evaluator (PSE) in the detection of deception was examined. The PSE is designed to capture inaudible changes in voice that may be related to stress in the act of deception. The manufacture of the PSE argues that the PSE produces results in the detection of deception that are comparable to standard polygraph methods. However, evidence for the PSE is very mixed and unclear. Also, the manufacture of the PSE claims that the PSE could be used with telephone recordings, and should produce results that are comparable to the ones with actual recordings. So, Waln and Downey (1987) tested if the PSE actually works with telephone recordings as well as with actual recordings.

In the present study, 15 recordings of previous job interviews were used. The same 15 recordings were also transmitted over the phone and recorded for the PSE evaluation. Four PSE examiners evaluated 15 actual recordings and 15 telephone recordings of the same interviews for an overall stress level and a stress level for each item. Recordings were ordered so that no recordings from the same interview appeared next each other.

Although both actual recordings and telephone recordings came from the same interviews, telephone recordings were evaluated as showing less stress than actual recordings. This pattern was particularly strong for relevant questions (e.g., "Have you stolen cash from a previous employer?") that were likely to influence a decision making process. In stress ratings, there was some consistency among PSE examiners, but the estimated reliability was low. The correlation between actual recordings and telephone recordings was also low. Thus, the present study showed that the PSE would not work with telephone recordings as well as with actual recordings. Also, the reliability of the PSE was found to be unsatisfactory in detecting the act of deception.

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