



TECHNICAL REPORT 62-16

AN ASSESSMENT OF LIE DETECTION CAPABILITY
(DECLASSIFIED VERSION)

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FOREWORD

"An Assessment of Lie Detection Capability" was originally published as a SECRET NOFORN document by IDA/RESO on July 31, 1962, as TR 62-16. The Director of Defense Research and Engineering, Department of Defense, deleted portions of the report and declassified the remainder on May 13, 1964. The declassified version was printed as Exhibit 25 (pp. 425 to 463) of "Hearings Before a Subcommittee of the Committee of Government Operations, House of Representatives, Eighty-Eighth Congress, Second Session, April 29 and 30, 1964," by the U.S. Government Printing Office.

Except for the forematter, this reprint of the unclassified version is a facsimile reproduction of Exhibit 25. Three asterisks (* * *) indicate that less than a paragraph has been deleted. A line of seven asterisks (* * * * * *) indicates deletion of one or more paragraphs.

The complete report retains its original classification.

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SUMMARY

This report evaluates the effectiveness of the polygraph method of lie detection. In this technique, the physiological responses of a person being interrogated are observed to provide a basis for inferring whether or not an attempt has been made to deceive the interrogator. The major finding is that, although the method of lie detection has been used extensively and is regarded favorably by its practitioners, the degree of its validity is still not known. This situation is the result of a failure to collect objective data necessary to assess the effectiveness of this method of interrogation. The report describes the methodological problems which must be faced in order to collect meaningful data, recommends research which should be undertaken to increase our understanding of this technology, and makes suggestions for improving professional standards in this area.

CONCLUSIONS

1. Objective data to demonstrate the degree of effectiveness of the polygraph as an instrument for the detection of deception has not been compiled by the agencies that use it in the Department of Defense. This is true despite the fact that about 200,000 such examinations have been performed over the last 10 years. Up to the present time, it has proved impossible to uncover statistically acceptable performance data to support the view held by polygraph examiners that lie detection is an effective procedure.

2. There can be no doubt that the measurement of physiological responses in the context of a structured interview provides a basis for the detection of deception by objective means. Extensive research by physiologists and psychiatrists shows that humans exhibit many physiological responses in stressful situations; however, such research was not performed to explore its relevance to lie detection. Thus, we do not know at present the increment in effectiveness which the polygraph brings over an interrogation without a polygraph.

3. There is a lack of professional standards for the regulation of lie detection activities throughout the Department of Defense.

4. Many aspects of the technology of lie detection are inadequately developed. Areas which require study are the reliability and validity of lie detection in laboratory and real life situations, the incremental value of new physiological indicators, improvement of the interview procedure, application of automatic data processing to polygraph records, and examination of the possibility that individuals exhibit unique patterns of autonomic response. Recent developments in medical electronics provide more reliable and convenient sensors than those now used in lie detection. * * * The research problems

in lie detection are straightforward and there is every reason to believe that a research program would achieve its objectives.

5. There is evidence that training, possibly supported by drugs and hypnosis, can be used to introduce spurious effects into test records. The extent to which such methods could succeed or an examiner could counteract them is unknown.

6. Improvements in the art of lie detection would be useful not only for its present applications to security and criminal interrogations, but for screening foreign personnel and as one means of inspection in an arms control agreement.

RECOMMENDATIONS

1. Establish a program for research and development in the technology of lie detection: This program should include studies on the validity of lie detection, improvement of interview procedures, the development of improved sensors, the effectiveness of adding new physiological indicators to the polygraph, and automatic data processing of test records. There is a need to study measures that could be taken to avoid detection on the polygraph and, if they are shown to be effective, to develop suitable countermeasures. The program should also include studies on the effect of cultural and political influences on the value of lie detection, if it were considered as one means of inspection in an arms control agreement.

2. Establish a program to develop professional standards for polygraph interrogation throughout the Department of Defense: This program should consider selection, training, and certification of examiners; methods of supervision; methods of maintaining competence; recordkeeping and performance evaluation; and relation of operating personnel to research and development activities in this area.

AN ASSESSMENT OF LIE DETECTION CAPABILITY

1. PURPOSE OF THIS REPORT

The purpose of this report is to evaluate our ability to detect deception by the objective measurement of physiological responses, a procedure known as lie detection. The Department of Defense and other Government agencies employ lie detection procedures in certain aspects of their programs and in criminal investigations. Recently, lie detection procedures have been proposed as one means of verifying compliance with the terms of an arms control agreement. Since great reliance has been placed on this method of interrogation, an assessment is in order to determine whether any improvement in the technology of lie detection is required at the present time.

2. INTRODUCTION

It has been long known that the emotional states of human beings are accompanied by observable physiological responses, such as changes in heart rate, breathing, and skin temperature. These physiological mechanisms are largely under the control of the autonomic nervous system although, to a lesser extent, some of them are also under the person's voluntary control by direct or indirect means. The inner psychological state of one person is not directly observable by another but it is possible that the pattern of physiological responses to neutral

and to probing questions could permit a useful degree of discrimination between deceptive and truthful responses.

It is undoubtedly true that the measurement of physiological responses can be used to indicate the presence of subtle emotional states in many and perhaps in most people. What is not as well known is the accuracy with which such objective measures can indicate that an individual is attempting deception. This problem exists because a person being interrogated may be upset but not guilty. He could be upset, for example, by the interrogation procedure itself or by the aggressive manner of the interrogation. He could be embarrassed by the exposure of personal information not related to the purpose of the interrogation. The problem becomes one not of determining whether the person is responding emotionally but *why* he is responding emotionally.

The history, as well as the theory, method, and legal aspects of lie detection have been described elsewhere (Inbau and Reid (1953),¹ Trovillo (1939), Marston (1938), Lee (1953), Larson (1932)) and will not be summarized here except to assist the reader.

The basic method of lie detection and its associated equipment have been in use for about 50 years and much has been written about it. Nevertheless, few data are available at the present time concerning the effectiveness of lie detection. The existing data are not easy to interpret. This is due principally to the fact that lie detection equipment operators, primarily in police, civil, and military security organizations, have not collected objective information concerning their methods and their results and probably do not appreciate the importance of doing so. On the other hand, few scientists have shown any interest in performing research on lie detection and, therefore, little has been done to clarify the problem. The inference that our knowledge about the effectiveness of lie detection is inadequate probably will be challenged by most polygraph examiners. The simple fact is that the data necessary to verify the results are not available. The use of lie detection methods has increased greatly over the last 10 years and perhaps this situation is now ready for improvement.

At one time it was believed that lie detection equipment provided direct evidence of lying. This claim is no longer made explicitly though the equipment is still referred to as "the lie box." Now, it is recognized that the equipment measures physiological responses, while it is the operator who infers deception from the physiological and other data. It has become known that fear of detection of deception is not the only emotion that may be encountered during an interrogation since other emotions, such as resentment or anger, can also be present. The individual being interviewed may be embarrassed or feel guilty because of personal experiences not related to the subject of the interrogation. The presence of such emotions could contaminate an inference about attempted deception. The polygraph examiner attempts to identify a pattern of emotional responses which recurs only with a specific category of questions and it is precisely the accuracy with which this function can be performed which has not been objectively determined.

Lie detection equipment can be regarded only as an adjunct to, and not the sole means of, conducting an interrogation. Apart from the equipment, many other factors affect the outcome, such as the method of interview, expertness, and detachments of the examiner, and the accuracy of background information used for comparison with the interview results. Each affects the accuracy of an inference as to whether or not the polygraph record indicates deception. Such matters will be examined in this report.

A. METHOD OF STUDY

For the purpose of this study, visits were made to many organizations which employ the polygraph to discuss the procedures and to examine evidence for the effectiveness of this method. Both Government and non-Government agencies were visited. The Government organizations visited were those concerned with security operations, criminal investigations, research and development—all related to lie detection. Several all-day conferences were held with polygraph examiners and research scientists. The subjects of these companies were: (1) Research to improve lie detection * * *. There is a large literature pertinent to lie detection and this was examined extensively.

B. OPINIONS ABOUT LIE DETECTION

Virtually all polygraph examiners believe that lie detection procedures are highly successful, an opinion which has the benefit of substantial repetition.

¹ A complete bibliography appears at the end of the report.

Favorable testimonials may be found in seminars held by the Academy for Scientific Interrogation (Leonard 1957, 1958) and throughout the *Journal of Criminal Law, Criminology and Police Science*. Alva Johnston (1944) wrote an entertaining series of articles on "The Magic Lie Detector" for *The Saturday Evening Post* about the work of an early exponent of lie detection, Leonarde Keeler, who is highly regarded by other polygraph examiners.

The polygraph also has detractors, three of whom may be briefly mentioned. Senator Wayne Morse (1952) regarded with disfavor the use of the lie detector in testing job applicants for the Defense Department because some interviews probing for homosexual tendencies appeared to be salacious in nature. Dwight MacDonald (1954) wrote two critical articles in *The Reporter* (a magazine) which emphasized the point that unethical practices in lie detection could constitute an abuse to civil liberties. Burack (1955) is concerned with the lack of professional standards in polygraph work and the lack of reliable data on the accuracy of the method.

There have been several surveys of opinions about the accuracy and value of lie detection tests. Cureton (1953) reports a poll of 88 psychologists conducted in 1926 by Dean C. T. McCormick of the University of North Carolina Law School. Replies were received from 43 percent of those who were polled; about half of these believed that lie detection tests furnished results of sufficient accuracy to warrant consideration by judges and jurors; about one-third indicated lack of belief.

In 1941, Dael Wolfe prepared a memorandum for the National Research Council on the use of lie detection equipment by the Federal Government. The memorandum is based on a survey of published literature, correspondence, and discussions with six expert polygraph examiners, nine research psychologists with some (but less extensive) experience in crime detection, and on observation of the work of the Chicago Police Laboratory and of some private laboratories. Thirteen of the 15 men (87 percent) felt that lie detection equipment in the hands of highly trained and experienced examiners provides accurate results where real criminal behavior is involved. Wolfe concludes that "with highly competent and well-trained operators a record of approximately 80 percent correct can be predicted."

In connection with a symposium on lie detection at the University of Tennessee College of Law, Cureton (1953) sent questionnaires to all groups and individuals known or believed to have some competence with polygraph procedures; i.e., polygraph examiners, psychologists, and criminologists. Analyses reported in the study are based on 711 completed questionnaires; i.e., 42 percent of 1,682 which were sent out. The data are shown in table 1. The belief that the polygraph is a highly valid device for recording physiological reactions may be found in decreasing order of agreement among polygraph examiners, polygraph examiners who are also psychologists, and psychologists who have observed polygraph tests. No appreciable portion of any group considers the polygraph invalid or useless when in competent hands. Psychologists who are not familiar with the device have a lower esteem for it than do those who are familiar with it.

TABLE 1.—Opinions of polygraph examiners and psychologists as to the validity of polygraph procedures

This table shows the replies of 711 persons. Numbers in parentheses indicate the size of each group; the total exceeds 711 because of some overlap.

Opinion	Percent of group holding opinion			
	Polygraph examiners (199)	Psychologists who have conducted polygraph tests in class or who have observed tests on suspects (230)	Polygraph examiners who are also psychologists (35)	Others (289)
The polygraph is highly valid for recording physiological reactions.....	83	63	63	15
Recommend court testimony on polygraph tests by competent examiners.....	47	51	60	42
Recommend periodic examination of certain personnel in business and industry.....	83	28	51	17

C. APPLICATION OF THE POLYGRAPH

Many agencies of the Federal Government employ the polygraph method of lie detection in the security program and in criminal investigations, as follows:

(1) Preemployment screening in sensitive agencies: To judge the accuracy of information provided by an applicant on a personal-history questionnaire (i.e., attempted deception). In one agency, the polygraph test is administered before a background investigation is undertaken while in another agency only after the investigation has been completed. Critical areas where a truthful reply is sought include membership in Communist organizations, association with Communists, relatives living in Communist countries, conviction of a felony, history of emotional instability and homosexual activities.

(2) Prior to assignment to sensitive activities: Some organizations use lie detection prior to special assignments even though a person may have been cleared previously.

(3) Periodic security review: Periodic rescreening of all members of certain organizations for recent evidence of homosexual activities, security violations, etc.; and to verify the reports and activities of individuals who have returned from special overseas assignments which may have brought them into contact with enemy agents.

(4) Screening refugees or foreign agents: To evaluate the personal reliability of foreigners when a thorough background investigation is not possible; though preferably conducted in the foreigner's language, such tests are sometimes conducted through an interpreter.

(5) Criminal interrogation: To provide independent verification of information collected by other means in criminal investigations. In the military service, this applies to thefts of personal or Government property, arson, murder, willful destruction or sabotage of Government property, and, of course, serious violations of the security regulations.

Many police departments employ lie detection equipment in support of criminal investigations; the examiner may be a police officer or a private examiner hired for the purpose. Some commercial organizations and private examiners offer lie detection services on a fee basis to banks, supermarkets, department stores, and industrial organizations. The purpose of such services is to encourage honesty in filling out preemployment questionnaires and in the handling of money or expensive merchandise.

On an experimental basis, two of the three indicators used in lie detection equipment (galvanic skin response and respiration) have been employed to measure the level of interest in advertisements and in TV programs. The responses of a group of individuals have been measured simultaneously for such purposes (Backster, private communication, 1959, 1962). This work has not been reported publicly and its value (if any) is not known.

Many physiological responses, including those used in lie detection instruments, have been studied in research on emotions, drug effects, learning, bioastronautics, environmental contamination, hospital surgery, fatigue, personality, and psychotherapy. The purpose of these researches was not lie detection though some of the results can be applied to this field and will be reported below.

D. LEGAL STATUS

Some lawyers have been attracted by the possibility that lie detection could provide a powerful assistance to the ever difficult business of assessing the validity of testimony. This type of application has both proponents and opponents (Wicker (1953), McCormick (1926), Summers (1939), Burack (1958)).

At present, information collected "solely" by means of lie detection tests cannot be entered as evidence either in a civil procedure (Inbau and Reid, 1953, pp. 122-141) or a court-martial (Everett, 1955). The major reason cited by the courts is that lie detection does not have sufficient "scientific recognition among physiological and psychological authorities" to warrant the admission of testimony (*Frye v. U.S.*, 1923; *Henderson v. State*, 1951). The word "solely" is important because confessions otherwise obtained properly are not rendered inadmissible by the fact that a polygraph was used during the interrogation (Wicker, 1953). A polygraph examiner can be permitted to testify as to a confession received during the course of an examination even though the charts themselves are not admissible.

There are two exceptions to the general statement of inadmissibility:

(1) Judges in trial courts have admitted polygraph results when both parties in a trial agree to take such a test, agree on the examiner, and with their attorneys, sign a stipulation agreeing in advance to the admission of the examiner's testimony on the same basis as other expert testimony.

(2) Some trial courts have admitted test results as evidence but whenever appeal has been made to higher courts, the latter have held that the test results are not admissible. Wicker (1953) cites 16 such cases.

A person cannot be forced to take a polygraph examination against his will and, in any case, it is doubtful that an effective examination could be accomplished on an uncooperative person. Adequate precedents have established that measurement of physiological processes and biochemical analysis of blood and urine for alcohol are not *per se* self-incriminating. However, since a person cannot be forced to testify against himself, neither can he be coerced into providing samples against his will. Thus, it is possible that the results of lie detection tests to which one has submitted voluntarily can, when and if there is greater agreement as to their validity, be introduced as evidence in legal proceedings.

The New York State Bar Association has sponsored legislation which would permit a court to order any party or witness to submit to lie detector tests and permit the results of such tests to be received in evidence on an issue of deception (Chatham, 1951). Polygraph examiners in New York, Illinois, California and the District of Columbia have supported legislation to establish licenses and standards for civil practice. Some labor unions have sponsored legislation to ban the use of the polygraph as a condition of employment. No attempt at legislation or licensing in behalf of the polygraph has yet been successful. In Boston, an act bans the use of the polygraph as a condition of employment.

Before proceeding with an examination, it is customary for the polygraph examiner to receive a signed and witnessed statement that the person who takes a test does so on his own free will. The agreement form reduces the opportunity of a disgruntled subject to claim that he had been coerced to submit to a polygraph test. The basis for this in military law is Article 31 of the Uniform Code of Military Justice which directs that no person subject to the Code shall interrogate or request any statement from an accused or a person suspected of an offense without telling him the nature of the accusation and that any statement made by him may be used as evidence against him in a trial by court-martial (Everitt, 1955). Thus, a person accused by the military has the right, as do those in civil life, to refuse a polygraph test. In one activity, the person to be tested executes a waiver which is usually witnessed by the polygraph examiner alone; in other activities, two witnesses and the examiner must sign before the examiner is authorized to proceed.

3. LIE DETECTION EQUIPMENT

Current lie detection equipment measures simultaneously three physiological responses:

	Device	Method of sensing
Physiological response: Breathing pattern.....	Pneumograph.....	Corrugated rubber tube around chest.
Blood pressure and pulse.....	Cardio-sphygmomanometer...	Pneumatic pressure cuff around upper arm (or around wrist and forearm to minimize discomfort).
Skin resistance to external current.	Psycho-galvanometer.....	Finger or palmar surface electrodes.

The phrases "skin conductance," "electrodermal skin response," "psychogalvanic response," and "galvanic skin response" are used interchangeably to refer to the same phenomenon. In this paper, we will use only the phrase "galvanic skin response" and the letters "GSR."

Recent developments in medical electronics have made it possible to measure the breathing pattern, blood pressure, and pulse with electrical devices that are more accurate than the pneumatic ones which are in current use. It is also possible to interpret physiological responses by the use of automatic data processing equipment. The application of such procedures to lie detection is just beginning to be explored.

Four companies produce virtually all the equipment used by professional lie detection examiners:

Associated Research, Inc., Chicago, Ill.: Keeler Polygraph.

C. H. Stoelting Co., Chicago, Ill.: Deceptograph.

Lafayette Instrument Co., Lafayette, Ind.: Polygraph.

Lee & Sons, San Rafael, Calif.: Berkeley Psychograph.

These devices cost from about \$600 to \$2,000 depending on the model and associated equipment. Though each device has its partisans, there is little to choose between them. Other equipments also exist but they are not in general use:

Darrow Photo-polygraph (Stoelting).

Higley Reactograph.

Electronic Psychometer (B & S Associates).

Cardio-pneumo-polygraph (Stoelting).

Electronic Lie Detector (Thompson Metrigraph Labs).

Chatham Polygraph (Associated Research).

Pathometer (Fordham University).

The term "polygraph" refers, most precisely, to the multiple-pen subsystem which records the instrumental responses on a roll of paper; through usage, it has come to represent the entire lie detection equipment. Frequently, an extra pen is used to mark the times during the interview at which questions were put to the person being examined. A time marker is not required because the recording paper contains time marks and is run at a constant speed of 6 inches per minute. More than three physiological responses may, of course, also be recorded on a polygraph but this is not typical in routine lie detection. One examiner employs two pneumograph tubes, one on the upper and another on the lower chest; many examiners are known not to use one (it may be any one) of the three "standard" indicators.

Suggestions have been made that other physiological responses, such as face temperature, electro-cardiograph (EKG), and electro-encephalograph (EEG) should be included in lie detection work but virtually no research has been accomplished to learn whether the addition of these indicators would increase the accuracy of lie detection. On the other hand, instruments which measure 10 physiological variables simultaneously are common in medical and psychophysiological research; one such instrument can record 20 channels in a form suitable for automatic data processing.

4. "THEORY" OF LIE DETECTION

Lie detection is an empirically developed procedure without an adequate theoretical foundation; it is an art and not a science. Lying may be a widespread and popular pastime but no attempt has been made to account for the extent and variety of physiological and behavioral responses which may be observed when a person attempts deception. To the best of our knowledge, there is not even a taxonomy of lying which defines the situation and purposes for which one person might attempt to deceive another. When one considers the amount of deception thought to exist in everyday life, it is surprising that no genius has arisen to codify this area.

As early as 1917, Marston recognized that some physiological responses probably always are present during an interrogation, whether or not a person is lying, but he thought that their magnitude would be larger when a person tries to deceive. The greater response would be due to some residue of learning, explainable in such terms as conditioned responses, conflict, or a threat of punishment (Davis, 1961, p. 161). However, the theoretical aspects of lie detection still await exploration and it is difficult to believe that this area of technology can develop without a theory.

5. EFFECTIVENESS OF LIE DETECTION METHODS

It should be possible to estimate the effectiveness of lie detection by the same methods that are employed in all classes of scientific observation and we shall start by examining the reliability and validity of lie detection.

A. VALIDITY

Validity is defined as an estimate of the extent to which an instrument (or test) measures what it is supposed to measure. As applied to lie detection, validity may be estimated by comparing the agreement between conclusions derived by use of the polygraph with other, independent measures of deception (or truthfulness). For example, a judgment, based on examining a polygraph record, that a person attempted to deny a previous conviction for felony may be compared to a court record of conviction. For practical purposes, independent

evidence for validating lie detection tests would be gained from thorough background investigations. A confession of guilt (or the admission of an attempted deception) is often used for estimating validity but it is not a completely satisfactory independent criterion. It is rarely clear whether the confession came before the polygraph was attached or after; or whether a complete polygraph test was run; or whether the interrogator made his "judgment of deception based on the polygraph" before or after the confession. To put it simply, the nature of police or security work does not lend itself readily to precise experimental control. In many such cases, independent verification by other than self-incriminatory means, may not be achievable.

Lie detection would exhibit high validity when polygraph-derived data are consistent with independent data on deception, such as when those judged to be deceptive are later found to have been deceptive, and those judged to be non-deceptive are later found to be nondeceptive, etc. There would be low validity when those judged to be truthful are found later to have practiced deception; or when those judged to be deceptive are found later to have been truthful. In real life, the problem of determining validity is complicated because those who are judged to be deceptive are not ordinarily hired and that ends the matter; no further investigation is conducted to determine whether or not the person actually was deceptive, although that would be required to clarify the problem of validity. A thorough appraisal of validity would require data in nine cells:

Polygraph judgment	Independent evidence		
	G guilty	Innocent	Indeterminate
Guilty (or practicing deception).....	*		
Innocent (or not practicing deception).....		*	
Indeterminate (no conclusion possible).....			

Obviously, high validity would require that the preponderance of cases fall in the starred (*) cells; and validity would decrease as the percent increases in any of the other cells.

B. RELIABILITY

Reliability measures the extent to which a test produces consistent or reproducible results. Reliability refers to the accuracy of measurement and should not be confused with validity. A test cannot be valid without also being reliable. Various aspects of reliability can be measured in the following ways:

- (1) Comparing the results achieved by two or more examiners working independently on the same case material.
- (2) Comparing the results of two or more tests on the same person taken at separate but close time intervals.
- (3) Comparing the results of one part of an examination with another, e.g., odd versus even items on one subtest, two different physiological indexes, or two different methods of examinations (viz., peak of tension versus questionnaires).

In the current practice of lie detection, no attempt is made to measure the absolute values of the three physiological responses which are being recorded, though many such schemes have been proposed. The examiner judges the responses in a qualitative fashion, using visual inspection to compare the magnitude and pattern of responses to relevant and irrelevant questions. There is no objective method of reporting test results.

Little attention is directed to the accuracy of the three instruments used in the polygraph, though they may be precise enough for present purposes. The breathing and blood pressure instruments operate on pneumatic pressure and their response characteristics are obviously nonlinear. According to one manual,² air leaks in these two systems should not exceed a pen excursion of 0.25 inches in 30 seconds for the pneumograph and of 0.25 inches in 10 minutes for the sphygmomanometer. Disregarding the rate of leak, this is a 5-percent error over the entire scale of 5 inches; the true error would be two to three times larger than 5 percent because the three tracings share the 5-inch scale. The psychogalvanometer is a sensitive instrument which must be adjusted continuously to contain the responses on the scale; some units incorporate a self-centering feature. Darrow (1929) and Lacey (1949) have shown that, among the several possible ways of measuring the GSR responses (based on conductance or resistance), the log change in conductance is the most reliable one. Martin

² Prepared by the Office of Naval Intelligence.

(1956) reports that the reliability of the GSR, measured as average skin log conductance, was 0.95 for a series of four sessions; although the absolute conductance values may change, individuals consistently maintained a large or a small response from one session to another.

Except for Kubis (1962), no one has explored the possibility that two examiners working independently might make different interpretations of the same record. Reliability of the polygraph in the sense of the consistency of measurement, i.e., agreement among examiners, is an unknown quantity.

C. EVIDENCE AVAILABLE IN THE GOVERNMENT

It is estimated that military and security agencies have conducted almost 200,000 polygraph examinations over the last 10 years, largely in connection with security screening. However, this experience has never been summarized and it is doubtful whether data remaining in the files can be utilized to provide an assessment of its effectiveness. Despite general assurance to the contrary, recordkeeping and performance appraisal on the use of the polygraph in the Government appears not to have been accomplished. If any review has been performed, the method of analysis and the results are not available for inspection despite a specific effort made to uncover them for this study.² A private organization which provides polygraph services on a fee basis was approached because its research director says that his reports are available for inspection by other

² As might be expected, this statement drew some replies from examiners who reviewed a working draft of this report:

(1) "Studies have been performed at . . . correlating the results of polygraphs and background investigations. No studies have or can be made of the absolute validity or reliability of the polygraph by personnel assigned to this unit. The worth of the program in terms of confessions and information of security value has been established beyond cavil."

(2) "We feel that your report could only be improved with the inclusion and analysis of more complete statistical evidence which we both know is either nonexistent or not readily available to you."

(3) This statement "does not apply to the U.S. Army Military Police Corps. While it is true that certain data is not available in the Office of The Provost Marshal General, much information is available at major operating command headquarters and at the Provost Marshal General's School. The Provost Marshal General's School is continually testing and evaluating lie detector performance, to include improved application and examination techniques."

The Provost Marshal also provided the data shown in table 2. Indeed, these data are useful. It shows that among 1,302 examinations in which deception was indicated, 52 percent led to admissions and 19.8 percent were verified by further investigation, while 27.5 percent could not be substantiated. For examinations in which no deception was indicated, contrary results were obtained by other means in 2.3 percent (78/3,153) of the cases; 3.6 percent (167/4,622) of the examinations were inconclusive.

From the data, it is not possible to make any judgments about effectiveness of the polygraph in security investigations because success or failure to detect deception in such cases (117 among the 4,622) is not broken out in the table.

TABLE 2.—Summary of lie detection examinations performed by the U.S. Army Military Police. (See exhibit 26, p. 463.)

Total examinations conducted-----	4, 622
Murder-----	28
Rape-----	96
Burglary-----	223
Security-----	117
Others-----	4, 158
Refusals to submit to examinations-----	386
Admissions obtained in pretest interviews-----	438
Admissions obtained during or immediately after execution-----	478
Examinations in which deception was indicated-----	1, 302
Examinations in which these indications led to admissions/confessions during examination-----	686
Examinations in which these indications were verified by further investigation or interrogation-----	258
Examinations in which these indications were not substantiated through investigation, interrogation, admission, or confession-----	358
Examinations in which no deception was indicated-----	3, 153
Instances in this category in which contrary results were obtained through investigation or interrogation-----	73
Instances in which results of examination in this category were in accord with results of other investigative techniques-----	3, 080
Examinations which were inconclusive-----	167
Complaints, if any, made against the lie detection examination procedure by those who were tested-----	4

examiners or by qualified research personnel. The research director was not able to provide a record of the successes and failures of his organization.

Therefore, although the polygraph enjoys wide usage, we are not able to estimate its value. It is possible that the regard in which it is held is due largely to the ability of the examiners to conduct effective interviews and only slightly to the polygraph instrument itself; or the reverse. We do not know. Unless performance data are kept and analyzed, we cannot benefit from experience and recognize the areas in which improvement is possible. This cannot be desirable to the agencies which employ this method or to the polygraph operators who are responsible for providing an effective program. No useful purpose can be served here by providing still another testimonial of faith in the lie detector. Objective data and not testimonials are required. The simple fact is that the necessary data have not been kept and that an impartial appraisal of the polygraph has not yet been accomplished.

This implies no lack of respect for polygraph examiners. The author was impressed by the apparent sincerity, conscientiousness, and integrity of the examiners who conduct the interrogations and supervise the use of the polygraph. The author joins them in believing that the polygraph "works," and that it has been employed in a scrupulous manner. However, belief in the value of the polygraph or in the integrity of its practitioners is not evidence that the polygraph is an effective instrument.

The following claims, made verbally, show the result of nine visits to five Government organizations in search of data. Most of the data reflect experience in security screening. No records were offered for inspection; the numbers are based on notes made during the visits:

[In percent]

	Verified acceptances	Verified rejections	Inconclusive determinations	Demonstrated failures
Organization A.....	85	12	3
Organization B.....
Organization C.....	3.0
Organization D.....
Organization E.....	5	.1

Blank entries indicate that no data were provided in some interviews; two organizations (B and D) appear not to keep performance data. "Inconclusive determinations" refer to cases in which the polygraph tracings did not permit the examiner to infer whether or not a person was deceptive (all other determinations are considered "conclusive"). "Verification" indicates that the judgment made from the polygraph record was supported by independent evidence. When the polygraph is used as part of the preemployment procedure for security screening, the term "verified acceptance" indicates that the polygraph-derived conclusion agrees with an independent background investigation and that the candidate is hired; "verified rejection" indicates confirmation of a decision not to hire. The distinction between acceptance and rejection is not considered significant for purposes related to accuracy of the polygraph since the percentage found in either category depends upon the type of applicants who appear for employment and the current criteria for acceptability; the percent of rejections is affected by the examiner's tendency to "play safe" by rejecting applicants whose record might in other circumstances be judged "inconclusive."

The total of verified judgments was reported to range from about 95 to 97 percent. "Failures" represent individuals who were hired but later found to be unacceptable or to have been deceptive. In these data, the failure rate is given as 0.1 percent; the report of 3 percent in organization C is not regarded as typical because it represents a single individual in a sample of 37 cases.

A private research organization, which works solely for one of the military services, instituted a program of semiannual polygraph examinations for its employees. The purpose of the program was to detect and to deter the illegal disclosure of classified information; on an initial examination, employees were asked questions concerning possible falsification of the personal history form and about homosexuality. Preemployment examinations were not given and it was not mandatory to take the test.

A total of 4,573 examinations were conducted over a period of 8 years. In 27 (0.6 percent) of these cases, a report was made to the Security Office that the polygraph examination indicated certain undesirable characteristics or incidents, e.g., suspected Communist associations or homosexuality. As a result of reporting such information and of subsequent investigation by the Security Office, seven persons (26 percent of the 27 cases) were separated from the organization; the remainder (74 percent) retained their clearances and employment. Thus, among the 27 cases recommended for further investigation, reasons for separation were found in 26 percent and not found in 74 percent of the cases. The polygraph program has been discontinued at this organization though, in the view of the security staff, it was proven to be effective and it had continuing value as a deterrent.

Two comments in the open literature, probably based on security screening for two large Government agencies, supplement our table:

"Our own experience, covering more than 100,000 polygraph examinations (90 percent of which were personnel examinations) has recently been evaluated and reveals that in personnel work the proved margin of error is less than 1 percent and uninterpretable records did not exceed 2 percent" (Chatham, 1953, p. 917).

"Most well-run polygraph examinations claim accuracy of 98 percent and on up without undue exaggeration depending on the type of cases being processed" (Leonard, 1957, p. 43).

Thus, polygraph examiners believe that the polygraph produces verified results in 95 percent or more of the cases. However, data from which this conclusion may be derived are notable chiefly by their absence. In any case, they are not available for review and one may reasonably doubt whether such data exist in a form amenable to objective analysis. It is clear that no thorough review of these data has ever been accomplished and there is no demonstrable basis for an objective judgment for or against lie detection.

D. EVIDENCE REPORTED IN THE LITERATURE

Anecdotal evidence in support of lie detection is readily available in the literature. This type of evidence consists of charts collected in criminal cases, their interpretation (generally successful), and suggestions for conducting polygraphic investigations. These charts are useful for instructional purposes, but since they describe only selected cases, they provide no evidence for the percent of success or failure.

An extensive review of the literature produced data on criminal investigations and laboratory experiments which will be reported separately to preserve several distinctions between "real life" and "experimental" investigations. These distinctions relate to the degree of emotional involvement, the degree of control over the events which occur, and the precision of the data which differentiates these two situations.

(1) Criminal investigations

Table 3 summarizes the published data on the use of the polygraph in criminal investigations. The reports date from 1932 to 1953; no more recent data have been found. The crimes, which are not always described, involve the full range of police work, such as theft, embezzlement, and murder; one unusual report summarizes investigations concerned with claims about paternity.

It was not possible to devise a consistent means of describing the accuracy of lie detection procedures that would apply to all reports and therefore the table contains some explanatory comments. The following headings are used in the table:

(a) Verified reports: Instances where it has been possible to provide independent confirmation of a judgment based on the polygraph examination. The most frequent example is a judgment of guilt followed by a confession of guilt.

(b) Indeterminable cases: Cases where an independent confirmation has not been made. The most frequent example is a judgment (of guilt or innocence) for a crime not supported by a confession. Unfortunately, this category includes some inconclusive polygraph examinations, described below.

(c) Proved error: Cases where a judgment of guilt or innocence can be shown to be in error.

(d) Inconclusive polygraph examinations: Cases where the results of a polygraph examination do not permit the examiner to make a high-confidence judgment of guilt or innocence.

The following conclusions may be derived from the data in table 3:

(a) In criminal cases, judgments based on the polygraph often cannot be verified. When verification is possible, such as reported by Trovillo (1951), the accuracy of lie detection ranges from 50 to 85 percent, for cases in which guilty judgments were supported by a confession. (About half of the cases in this sample was judged guilty.) But Inbau and Reid (1953) estimate accuracy as the percent of cases in which the examiner made a definite determination of guilt or innocence rather than an inconclusive one. This is an unusual application of the term "accuracy" (also see below). For Larson (1932), accuracy of 100 percent is based on finding one thief among 90 college girls.

(b) There are few reports on proved error. Where data are reported, proven errors occur up to 2 percent. In these cases, the guilty are more likely to be judged innocent than are innocent persons likely to be judged guilty.

(c) Inconclusive polygraph determinations occur in 10 to 20 percent of the cases.

TABLE 3.—Accuracy of polygraph reported in criminal investigations

NOTE.—Numbers in parentheses do not appear in original reports but are calculations made by the author of this paper.

Type of investigation	Reference	Number of cases	Accuracy (percent)				Comments
			Verified reports	Indeterminable cases	Proved error	Inconclusive polygraph	
Thefts in a college dormitory. Criminal suspects.....	Larson, 1932 do.....	90 861	100 79.5	20.5	0		Based on confession of 1 guilty person. Difficult to ascertain author's meaning; 20.5 percent may refer to inconclusive category. Verified by confessions; original study of muscle tremors. "All examinations confirmed by confessions" or by subsequent investigations" (p. 340). "Several diagnoses later found guilty... not guilty later found innocent" (Wolfe, 1940). Accuracy not defined; used GSR. Suspect identified by witness and judged guilty after several lie detection tests; later exonerated by another's confession. No errors of diagnosis reported. . . . however, "no decision" category was rather large.
Murder suspects..... Criminal cases.....	Luria, 1932 Summers, 1939.....	(1) 43	(?) (100)				
Criminal suspects.....	Keeler, 1941.....		82	16.5	(?)		
Embezzlement. Do.....	MacNitt, 1942. Marcuse and Bittermen, 1946.	59 1	99		(?)		
Criminal cases.....	Kubis, 1950.....	(1)	(90)		0	10.0	

Category	Location	21	(95.3) (88.9)		4.7 11.1	(P. 760.)
Paternity cases:	Trovillo, 1951	21			4.7	<p>Verified reports apply only to those who were judged guilty and also confessed; indeterminate group ranges up to about 80 percent (my estimate), when innocent judgments are included (Trovillo, 1951, p. 758). These data also appear in Trovillo (1943, p. 342).</p> <p>Same data when given by Trovillo in 1943 includes 20 percent indefinite reports; 2 percent of those reported innocent later found guilty and 0.05 percent of those reported guilty later found innocent (p. 127). Trovillo does not claim 97.95 percent accuracy; Lee does. On p. 17, Lee says "only 12 mistakes in judgment in 2,171 cases," perhaps "2,171" is printer's error for "1,127" above.</p> <p>"Accuracy" here is number of cases tested minus those cases reported indefinite. Inbau's value of 0.0007 percent "proven error" is an arithmetic error; it should be 0.07 percent.</p>
Complainants	do	18			11.1	
Defendants	do					
Police examinations (total, 7,622):	Trovillo, 1951	774			1.0	
Michigan (1951)	do	395	50		12.4	
Texas (1951)	do	815	62		9.8	
St. Louis (1951)	do	3,200	50		12.0	
Detroit (1945-51)	do				4.0	
Toledo (1951)	do	412	64.5		5.0	
Seattle (1951)	do	175		2.3		
Illinois (1951)	do	245	75		2.0	
Dallas (1951)	do	479	47		20.0	
Chicago (1938-41)	do	1,127		2.0		
Criminal suspects	Lee, 1953	1,127		2.05		
Do	Inbau and Reid, 1953	4,280	95.6 (36.4) 11.7	(79.0)	4.4	

1 About 50.
 2 "High."
 3 Several cases.

4 1 case.
 5 Over 300. In a private communication, Kubis says that the number of cases given in the article is a typographical error; it should be 300 and not 500.

Some reports (e.g., Luria, Summers, Kubis) make a claim for high accuracy but offer no quantitative data. Kubis (1950) finds "no errors of diagnosis . . . (but the) 'no decision' category was rather large," i.e., 10 percent.

The report of Inbau and Reid (1953, p. 111) deserves a special comment. They determine accuracy as 95.6 percent by adding all instances in which examiners made judgments of guilt (31.1 percent) or of innocence (64.5 percent). In the remaining 4.4 percent of cases, the examiner could not make a conclusive judgment. They report no indeterminable cases. They report proved error in 0.0007 percent of the cases but this is an arithmetic mistake; using their own data (3 errors in 4,280 cases), this value should be 0.07 percent. Also, according to their data, there were confessions in 486 out of 1,334 reports of guilt; thus, verification of guilt was possible in 36.4 percent of the cases. In 323 out of 2,750 reports of innocence, another's confession confirmed the judgment; thus, verification of innocence was possible in 11.7 percent of the cases. Finally, note Kubis' (1950) report that in order to achieve zero errors of diagnosis, he had to accept 10 percent in the "no decision" category. This contrasts with Inbau's 4.4 percent.

However, the outstanding difficulty in interpreting the data in table 3 lies in the fact that, due to the circumstances of criminal work, the examiner often has independent knowledge; that is, not collected by means of the polygraph, which suggests whether or not the suspect is guilty. Therefore, his judgment of guilt (or innocence) is based to some unknown extent on a combination of polygraph responses *and* other information, and not on the polygraph investigation alone. It is never clear whether the judgment said to be made from the polygraph record was made before or after a confession was received. This makes it most difficult to assess the true accuracy of the polygraph when it would alone provide the information from which a judgment must be drawn.

(2) *Experimental investigations*

The advantage of laboratory studies of lie detection is that more complete control of the means of (and the reason for) collecting data is generally possible and, therefore, such data can be subjected to rigorous statistical analysis. The basic disadvantage of laboratory studies is that they may not be relevant to lie detection if they do not evoke "real" emotional responses of fear and anxiety similar to those present in real life, polygraph examinations. The latter contention is often made by lie detection experts, on the ground that less emotion can be aroused in the laboratory and that therefore the polygraph would show a lesser ability to detect deception under such circumstances. For example, Trovillo (1953) says:

"Simulated emotion in psychology classes, or the lecture platform, in drama, and in experimental laboratories has done more to clutter up and confuse honest polygraph reporting than all the quackery of 50 years" (p. 747).

"Much of the academic experimental validation of polygraphic technique is completely barren of significance. No matter how accurate and reliable the instruments used, if the controls used do not guarantee that *fear* is being measured, then all conclusions are not only irrelevant but hazardous. Future progress depends on use of experimental subjects experiencing drastic stress: the criminal suspect, not the laboratory liar; the mental patient, not the academic spoofer" (p. 762).

"The professor who buries his nose in textbooks and bores his students with myopic dronings over verbal autopsies will never be interested in conducting vital research in lie detection" (p. 762).

The results of laboratory studies, as shown in table 4, do not justify any antipathy toward experimentation on the polygraph. These studies show that polygraph judgments about deception in the laboratory are correct in about 70 to 100 percent of the cases; the median value in the table is about 92 percent. This is the range of values reported in "real life" investigations. Some recent studies, such as those of Lykken (1959, 1960), Kubis (1962), Marcuse (1946), and Baeson (1948) are well controlled and show that the polygraph can be used to detect deception (of the type which can be arranged to permit experimentation) by objective criteria in 90 percent or more of the cases. It is significant that accuracy increases when the examiner is prepared to report that some polygraph records are inconclusive, i.e., do not permit him to make a determination. Surprisingly in these studies few proved errors are reported. There may be a minority of people (perhaps 10 percent) on whom the polygraph may not work. If judgments of deception are required for such people, other means than the polygraph must be employed. Experimental data do not provide a blanket argument against the polygraph though they do remind us that the polygraph cannot deal with all cases.

TABLE 4.—Accuracy of polygraph reported in experimental studies

Type of investigation	Reference	Number of cases	Accuracy (percent)				Comments
			Verified reports	Indeterminable cases	Proved error	Inconclusive polygraph	
Noncriminals.....	Marston, 1921.....	35	94.2				Emphasis placed on GSR and cardiac amplitude; accuracy not defined. 81 college men, all judged innocent of a dormitory theft; after 1-5 retests Cardiovascular responses categorized on 1st test only: No reaction..... 38 Moderate, scattered..... 28 Extensive..... 25 More pronounced to relevant than irrelevant, i.e., guilty..... 9 Total..... 100 Agreement between 3 judges in categorizing responses 0.87 to 0.96 (cont. coef.). In 1/5 percent of cases, guilty person in each pair (rather than person with guilty knowledge) produced evidence required for identification. 1 or 2 trials insufficient but accuracy can reach 97 percent if many retests are permitted; no difference in polygraph response between delinquents and non-delinquents. Errors could be reduced 50 percent and accuracy would rise to 92 percent if more indeterminate judgments made; but those on whom polygraph could be used would drop from 100 to 72 percent (for this sample). Reliability: Records could be read in same way 1 month later in 84 to 94 percent of cases.
Do.....	Ruckmick, 1936.....	50	86.0				
Students.....	Summers, 1939.....	21	99.1				
Experimental cases.....	MacNitt, 1942.....	104	99.0				
Imaginary crimes.....	do.....	17	99.0				
Card tests.....	do.....	36	75.0				
Innocent students.....	Bitterman and Marcuse, 1947.....	61					
Distinguish guilt from knowledge about the "crime" in a mock theft.....	Dason, Chung, and Yang, 1948.....	100	86.0				
Mock theft.....	Rouke and Kubis, 1948.....	(1)	97.0				
Card guessing.....	van Buskirk and Marcuse, 1954.....	50	72.0-84.0				

See footnote at end of table.

TABLE 4.—Accuracy of polygraph reported in experimental studies—Continued

Type of investigation	References	Number of cases	Accuracy (percent)				Comments
			Verified reports	Indeterminable cases	Proved error	Inconclusive polygraph	
Mock crimes.....	Lykken, 1959.....	49	90.0-94.0				GSR only used objectively in guilty knowledge procedure; 100 percent innocents correctly identified, 88 percent guilty correctly identified. GSR only used objectively in guilty knowledge technique. Used objective judgments of examiners who did not know whether subject was guilty or innocent. Examinee's problem was to judge nature of crime. ¹ Accuracy dropped from 75 to 80 percent in control session to as low as 10 percent in experimental session.
Faking.....	Lykken, 1960.....	20	100.0				
Simulated theft.....	Kubis, 1962.....	336	73.0-92.0				
Denial of actual crime by ex-prisoners in an experiment. Test.....do.....	23					
Retest.....do.....		40.0				
Deliberate attempts to beat the polygraph in guessing a number.do.....	20	29.0				
do.....						

¹ 80 delinquents; 90 nondelinquents.

² Described more fully on p. 447.

(3) Methodological studies

Under this heading, we wish to review several experiments in which the polygraph or some of its component indicators was used, not always for the purpose of lie detection. In general, these studies show that the polygraph is a sensitive instrument so much so that the responses it measures can be affected by a variety of influences. Therefore, adequate controls are required before the polygraph can be used as an effective instrument. For example:

(a) Greater GSR responses were observed in 40 college students when a Negro rather than a white examiner operated the GSR instrument. Rankin and Campbell (1955).⁴

(b) The GSR response adapts (i.e., becomes reduced) most quickly to a light stimulus, next to a buzzer and least to a question (i.e., an idea). Demonstrated on 54 students by Kubis (1948).

(c) Even though electric shock was used every time the subject told the truth in an experiment where he tried to deny a number he had selected, the GSR response was not reversed. This demonstrated, on 23 students, the relative stability of objective criteria of deception and the accuracy of their identification under conditions designed to obscure the criteria and to confuse the diagnosis. Block et al. (1952).

(d) Innocence (of suspected criminals) can be determined objectively with greater accuracy than guilt. Only blood pressure records were used in a preliminary, feasibility study of 17 verified innocent and 33 verified guilty polygraph tracings. Leonard (1958, pp. 118-121).

(e) Though a sudden rise in blood pressure in response to relevant questions is generally suggestive of guilt, Arther (1955) shows four verified cases in which it occurred with innocent subjects. A "control question" technique has been devised by Inbau and Reid (1953) to avoid this possible error of interpretation.

(f) Polygraph experts who conducted an examination produced no more accurate judgments than did other examiners who had access only to the records of the same examination. This was accomplished in an experiment which was virtually real-life, involving a presumed disclosure of classified information. However, accuracy of both groups was not high. In the critical retest period, the examiners (those who performed the tests) were able to detect the two experimental lie situations in 41 percent of the cases; one of the two lies in 54 percent of the cases; and neither lie in 5 percent of the cases. The corresponding average percentages for raters (having access only to the records) were: 54 percent, 36 percent, and 10 percent. In the test session immediately following, the accuracy of examiners and raters dropped to a chance level. Adaptation was rapid and appreciable within the same day of testing. Kubis (1962).

(g) In a long series of experiments, Ellison (1952) showed that objective measures of such physiological indicators as GSR, breathing rate, breathing amplitude, breathing time, systolic pressure and diastolic pressure, when taken singly, rarely distinguish between deception and non-deception in more than about 75 percent of the cases. When these indicators are combined optimally by means of statistical discriminant functions, the accuracy rises to about 90 percent correct classification of liars in experiments. Greater accuracy is possible, but was not demonstrated in these experiments, provided that improved techniques and procedures are found to increase the statistical reliability of the individual measures.

Perhaps these studies are sufficient to indicate that the polygraph can demonstrate validity of the order of 90 percent in experimental situations. However, the polygraph test is subject to error when a variety of uncontrolled influences are present, some examples of which are offered in these studies. Greater accuracy may be anticipated by combining the results of several physiological indicators in accordance with statistical rules which reflect their predictive value, provided we can also increase the reliability of measuring these indications.⁵

⁴ A reviewer comments: An activity "has one Negro examiner. There has been no observable difference in the recorded patterns of his interviews of white subjects, compared with interviews conducted by white examiners." No data were offered to support this view, while Rankin and Campbell's data suggest that the reverse is probably true.

⁵ A polygraph examiner comments: "Methodological studies, as well as much of the literature in the field have, for some reason, emphasized research and experimentation on the galvanic skin response. This is somewhat anomalous, in view of the fact that many experienced and expert examiners place little or not credence in the galvanic skin response. Some competent examiners admit frankly that they do not even turn on the

6. THE PATTERNING OF PHYSIOLOGICAL RESPONSES

The conventional polygraph, with its three physiological indicators, obviously can be used to detect deception more accurately than would occur by chance alone. The reported accuracies are rarely below 75 percent and sometimes approach 100 percent. Two factors which probably influence a major portion of this variability are the procedures used by the examiner and the physiological responsiveness of the person being tested. Let us first consider the latter problem.

The three indicators used in the standard polygraph (breathing pattern, cardiac pattern, and GSR) measure only a few of a large number of known, autonomic response mechanisms. Measurement of autonomic responses is desirable because they are not primarily under the direct, voluntary control of the person being observed, even though some such influence is possible—more so for breathing and less so for the GSR. Activity of the autonomic nervous system can be measured by at least the following physiological responses:

Galvanic skin response	Blood volume in forefinger, leg
Breathing:	Blood oxygen saturation
Pattern of response	Skin temperature
Amplitude	Muscle tension potentials
Rate	Hand and finger tremors
Time	Eye movements
Vascular response:	Pupil diameter
Systolic blood pressure	Gastrointestinal motility
Diastolic blood pressure	Electroencephalograph
Pulse rate	Ballistocardiograph
Pulse time	Salivation
Pulse wave velocity	
Volume pulse	

This list could be extended and also replicated because there often are several ways to measure each physiological response. For example, there are at least four different ways to measure the GSR:

- Skin conductance.
- Log conductance.
- Skin resistance.
- Log resistance.

At the outset, it is important to realize that the autonomic responses are not necessarily highly correlated with each other. That is, even though all of these response mechanisms are influenced by the autonomic nervous system, the influences are not identical. Some mechanisms show large responses while others, at the very same time, show little response. Two mechanisms which show a large, initial response to an emotional stimulus may not adapt (i.e., return to their initial levels) at the same rate.

A wide range of physiological responses have been studied in connection with psychosomatic medicine, physiological correlates of personality, medical diagnosis, the measurement of anxiety states, and psychotherapy. In these areas of research, many studies may be found which clarify some of the problems encountered in the practice of lie detection.

Some investigators, such as Ax (1960), Wenger (1961), Malmö (1950), and Lacey (1958c) have measured simultaneously up to ten physiological variables and have evaluated the results in accordance with objective criteria. Methods for the simultaneous recording of up to 29 physiological processes and for automatic data reduction systems have been described by Ax (1960), Zimmer (1961), and Clark (1961).

According to Lacey (1958c), individuals exhibit idiosyncratic patterns of physiological response which tend to be repeated in various stress-evoking situations; six variables were measured. If such individual consistency is confirmed, physiological responses in emotional states would have to be interpreted on an individual, rather than on a general basis and a significant change introduced in lie detection procedures. Wenger (1961) measured eight autonomic responses in four different emotional situations. Although stable response specificity and stereotype occur to some degree, they are interpreted by Wenger as

galvanic skin response because of the impossibility of determining the source of galvanic skin response reactions. Others use the galvanic skin response as an aid but ignore it when its excursions conflict with the pneumograph and cardiophysymograph patterns."

caused in part by the method of measurement and in part by significant individual differences in the resting level of the autonomic functions. He cautions against overgeneralizing the significance and pervasiveness of autonomic response specificity and stereotypy. Few reaction patterns were identical for a subject under the four emotional conditions and this is further evidence against general interpretation of physiological responses. Using 7 responses (transmuted into 14 scores). Ax (1953, 1960b) obtained distinct but different physiological patterns for anger and fear. However, his study does not show much evidence for physiological stereotypy.

In a study concerned primarily with various techniques of quantifying autonomic responses, Dykman (1959), used the three conventional polygraph indicators on 40 medical students under conditions of rest, noise and responding to a series of emotional and non-emotional questions; lie detection, as such, was not attempted. He found:

(a) Skin resistance was the easiest to evaluate and the most consistent of the three measures.

(b) The autonomic responses diminish rapidly to a relatively constant level for each series of stimuli.

(c) Subjects are more reactive in skin resistance than in heart rate or respiratory rate, both in terms of the magnitude and frequency of response.

(d) The magnitude of autonomic response is dependent on the initial level of functioning; in general, the higher the initial level, the smaller the response.

(e) An individual's reaction in one autonomic subsystem cannot be predicted from his reaction in another.

These few studies, from among a large literature, show that a simple or purely mechanical treatment of the three polygraph indicators would lead to a low accuracy of lie detection. Polygraph operators deal with this situation in an intuitive manner, shifting from one indicator to another, in an unknown fashion, in order to analyze a record. Various "schools" of interpretation have developed in which the examiner emphasizes one of the three indicators to the relative exclusion of the others; each indicator is regarded by some examiner as the single, "best" indicator.*

Since, as a result of learning processes, individuals undoubtedly differ in the choice of response mechanism and degree of responsivity to emotional stimuli, there is an ample basis for various examiners to build up confidence in their own methods of analysis. But since intuitive, rather than objective, rules play a large role in the evaluation of records, the idiosyncracies of various operators undoubtedly contaminate the accuracy of the results. This may not be a problem for cases which are straightforward and routine but it must limit accuracy for the cases which are ambiguous or difficult to interpret.

A striking example is the "Total Chart Minutes" concept developed and copyrighted (1960) by Cleve Backster, director of the National Training Center of Lie Detection, New York, N.Y. The term "total chart minutes" refers to the accumulation of time during which a subject has been asked questions during one or more trials on the polygraph; i.e., the time between trials is excluded. The useful purpose served by this concept is that it attempts to account for the value found by some examiners for a preferred indicator as due to the phase of interrogation during which that indicator may be especially discriminating. A series of curves is provided which describes the relative effectiveness (from "excellent" to "poor") of the three standard tracings (breathing, heart, GSR) for a "probably innocent" or a "probably guilty" person for any period with the total chart minutes structure. No data are provided to verify the schematic curves; in fact, when asked for confirmation of this intriguing concept, Backster could (or would) not provide any corroborating data to support his thesis.

It becomes clear that in real life we cannot rely solely on the individual interpretation of an examiner without verification by independent means, such as another, completely independent evaluation by another examiner, or a background investigation, or both. The addition of independent data must increase the degree of confidence we can place in the final result. Thus, there is an urgent need for (a) multivariate recording in actual interrogations, (b) independent

*One polygraph examiner comments: "Granted that intuition may play a part in the analysis, but the analysis is more probably a Gestalt process, into which a great deal of experience on the part of the examiner is compounded." This reviewer noted that some examiners disregard the GSR.

judgments by more than one examiner, and (c) automatic data processing of these complex records.

We might, now, consider the implication of these studies for improving our ability to detect deception with the polygraph assuming, for this purpose, that adequate transducers and methods of measurement exist or can be devised. Although activity of the autonomic nervous system may be observed in many ways, the addition of new measures would not necessarily increase the accuracy of detecting deception. The value of additional measures depends upon the way in which deception affects various physiological processes. Assuming that the three present indicators do not adequately sample the physiological expressions of deception, it would make sense to add new response measures which fill this gap. Our knowledge on this point is slight. An estimate that the polygraph-and-examiner has a high accuracy (e.g., about 90 percent) does not provide an estimate of the variance due to each of the three polygraph responses alone or in combination or to the examiner. Therefore, we do not know whether there is room for improvement in the instrument or in the responses which are measured.

Current technology permits us to examine the value of observing the three current response mechanisms as well as the possible value of adding new ones. The essential device which has not been available previously is automatic data processing equipment. Ellison (1952, pp. 150-161) proposes that several indicators should be combined by means of discriminant functions to provide a more powerful indicator but points out that our ability to improve detection of deception will be limited by the reliability of the individual measures. The use of a computer to combine these variables for lie detection has been suggested by Zimmer (1961) who has assembled equipment for such an experiment but no results are available as yet. The work of Ax, Lacey, and Wenger, mentioned above, could readily be extended into the area of lie detection.

The many autonomic responses which may be added to lie detection are listed earlier in this report but they must be chosen so that only the more diagnostic ones are used. The three variables in current use will probably remain highly useful. Promising ones to consider are blood volume in finger, muscle tension, skin temperature, eye motion and electroencephalograph, the last if additional research clarifies the meaning of the phase changes. Initial studies involving multiple sensors would have to be accomplished in a laboratory setting with possible cumbersome equipment. However, great advances have been made recently in improving sensors and in reducing their size for use in hospitals, medical experimentation and the bioastronautics program and there is no reason to doubt that the necessary equipment can be made more convenient to use. This applies also to reduction in the size of any computing equipment that might be developed to perform on-line data processing of physiological indications but further speculation in this direction is premature. It is clear that the patterning of physiological responses in lie detection is an area in which additional research can be accomplished readily by taking advantage of existing techniques which have not, as yet, been applied to lie detection.

7. CURRENT RESEARCH ON LIE DETECTION

An organized research program to improve lie detection does not exist at the present time in the Government though scattered support, at the rate of about \$190,000 per year, may be identified. Within this small budget, more funds are devoted to the improvement of equipment than to basic or applied research. Some topics enjoy interest but no financial support. Finally, we will note briefly the existence of useful work in related areas.

A. GOVERNMENT-SUPPORTED RESEARCH

Government-supported research on lie detection is directed primarily toward improving existing instrumentation and developing a few sensors and transducers. A small effort is directed toward developing new procedures. The following listing is believed to represent the entire effort:

(1) *Miniaturized polygraph*

A prototype, transistorized polygraph weighing about 10 pounds will soon be available for evaluation. (Associated Research, Inc., already markets a 21-pound polygraph instrument which operates on four flashlight batteries and fits in an attaché case. C. H. Stoelting Co. has developed a 12-pound instrument which operates on 110-volt a.c. current.) Current "portable" equipment weighs up to 40 pounds.

On the new equipment, the breathing pattern will be sensed by a strain gage and cable tied around the chest rather than by a pneumograph. Blood pressure changes will be sensed by a piezo-electric crystal on the wrist rather than by the cardio-sphygmomanometer. Conventional GSR sensing is retained. This polygraph will produce a record very similar to the present one and its primary utility, in contrast to other equipment, will be its ease of portability.

(2) Rapid computer processing of involuntary responses

The Air Force Office of Scientific Research is supporting a project for rapid and accurate evaluation of psychophysiological responses by means of computer analysis.⁷ The purpose of the study is to devise methods which will provide an interviewer with reliable indications of the kind of information carried by the person being interviewed. Nine involuntary reactions will be studied:

- Muscle action potential voltage.
- Intersystole time.
- Finger pulse amplitude.
- Respiration cycle duration and amplitude.
- Skin resistance.
- Skin temperature.
- Body-weight shifts.
- Reaction time.

The equipment required by this project has been assembled and is being checked out; up to now, no data have been collected. This project has been referred to, erroneously, of course, as one in which a "red light tells when the subject is lying."

* * * * *

(4) Lie detection methodology

Dr. Joseph Kubis (1962)⁸ of Fordham University is conducting a series of studies to improve the methodology of lie detection also on project 5534. * * *. The study consists of four parts, some of which have been described earlier in this report. The following summary is based on a conference with Dr. Kubis at RADC on January 2, 1962, and represents his preliminary conclusions:

(a) Sham theft (360 subjects, 5 examiners) :

Examiners can correctly detect "innocent" or "guilty" students in 73 to 92 percent of the cases. Raters who worked only with polygraph charts (and did not see the "suspects") were as accurate as the examiners who performed the interrogations. In 112 sessions, 2 "innocent" students were called "guilty."

Of the three measures used by Kubis, the GSR response provided by far the greatest accuracy (about 90 percent for discriminating the "guilty" from "innocents"), while the other two indices (respiratory and plethysmographic) produced accuracies of only about 60 to 70 percent.

When discriminant functions are calculated based on the readings of different individuals analyzing the same data, they are found to differ appreciably in the assignments of weights to the three response indices. This lack of homogeneity among various discriminant functions suggests inherent difficulties for the development of computer techniques to provide objective indications of guilt or innocence.

However, considering the low objectivity realized by visual interpretation of respiratory and plethysmographic responses, computer techniques may well be a valuable adjunct to lie detection in the following respects:

- (1) Differentiating among complex physiological patterns.
- (2) Developing new indexes or criteria of deception.

(b) Denial of a previously committed crime by ex-criminals on parole (23 cases) : Since all subjects were known to be guilty, the experiment consisted of judging the type of crime committed. The subjects were told to deny a specific previous crime and each record contained two "lies." In 40 percent of the cases, the examiner was able to detect both lies in the records of the ex-prisoners; in 48 percent of the cases one of the two lies; and in 12 percent of the cases neither of the two lies. In a retest of the same subjects, 29 percent were detected in both lies, 57 percent in one of the two lies, and 13 percent in neither of the two lies. (Based on averages of 3 examiners.)

⁷ Grant AF-AFOSR 62-110 with the University of Georgia; the principal investigator is Herbert Zimmer.

⁸ Dr. Kubis' final report, noted in the bibliography, became available while this report was being printed.

(c) "Leak" of classified information: An attempt was made to conduct a "leak of classified information" experiment but this proved to be impracticable to perform. Although this would have closely approximated a "real life" situation, Kubis had to substitute for it a situation wherein the subjects denied knowledgeability of selected items of classified information.

(d) Countermeasure experiment: Subjects were trained to use several techniques to make it difficult for an examiner to interpret a polygraph record. The test required the examiner to guess a number on a card selected by the subject. The prescribed techniques and instructions were:

(i) Yoga: "Keep your mind as blank as possible and answer 'No' to all questions."

(ii) Muscle tension: "When some questions are asked, tense your body or foot so that the examiner doesn't see it and in a way that will mislead him, as to the number you have in mind."

(iii) Exciting imagery: "Think of something that is exciting to you, in a manner that will make it hard for the examiner to guess what number you have in mind."

Preliminary results for 20 subjects show about the following accuracy:

	<i>Accuracy (percent)</i>
Control (no instruction)-----	75-80
Yoga-----	75-80
Muscle tension-----	10-20
Exciting imagery-----	15-25

If a subject selected a decoy number on which he consistently tensed or used exciting imagery, he could direct the examiner to this number in 55 to 70 percent of the cases. Examiners are unable to distinguish among the known decoy and "real" numbers on the basis of the polygraph records. Though this was only a preliminary experiment, it is sufficient to show that it is possible to interfere with a polygraph. It is not clear whether an alert examiner could ascertain that the subject was trying to create a spurious response.

(5) Instrumentation and transducers

The work of Dr. David McK. Rioch at the Walter Reed Army Institute of Research, Washington, D.C., includes a continuing program for the development of new physiological sensors and transducers for research in the broad area of neuropsychiatry. And any new developments in psychiatric interview procedures, sensors, transducers or physiological recording, could be applied to improve lie detection.

* * * * *

(7) Staff studies

The Department of the Army⁹ is conducting a staff study to determine and recommend policies governing U. S. Army use of the polygraph for counterintelligence and security purposes. The method of study consists of a questionnaire and interviews directed to polygraph examiners. Results are not yet available.

The Office of the Provost Marshal General is modifying the monthly reporting procedure on polygraph examinations conducted in the Army to provide more detailed, statistical information.¹⁰

The Provost Marshal General's School is conducting research into the effect of hypnosis on interrogation. A preliminary report is that a post hypnotic suggestion can lead suggestible subjects to "forget" particular incidents.

B. PROPOSED RESEARCH

The research proposed below represents areas in which polygraph examiners have expressed interest. However, at the time this report was written, no formal projects had been established to perform these studies.

⁹ Project title "U. S. Army Use of Polygraph for Counterintelligence and Security Purposes" (U). ACSI-SC, June 8, 1961. The project officer is Maj. Uldrich H. Pettine, G-3, USA Intelligence Center, Fort Holabird, Md.

¹⁰ Operations Branch, Office of the Provost Marshal General, Department of the Army. The project officer is Lt. Col. Nicholas P. Rudsiak.

(2) New sensing devices

A variety of new sensors, such as those listed below, have been proposed to extend the capability of the polygraph:

- (a) Infrared sensing devices for remote measurements of skin temperature.
- (b) Devices to measure breathing pattern and heart rate based upon sensitive microphones, ultrasonic or radar-type equipment.
- (c) Electro-encephalograph: A helmet mounted device with 100 sensing elements; with computer processing, this would produce an intensity modulated display of brain activity, called a toposcope. * * *
- (d) Thermistors to measure skin temperature.
- (e) Strain gage on face or jaw to measure muscle tension.
- (f) Improved blood pressure measuring devices:
 - (1) Strain gages and an EKG lead (HRB-Singer).
 - (2) Carbon microphone attached to finger tip (Texas Instruments).
 - (3) Oximeter-type device attached to ear lobe.

Among these, it will be noted, are some new sensors and some which do not have to be attached to the body. Background research to explore the possible value of new sensors for lie detection is rarely considered because their novelty is taken as *a priori* evidence of utility. In the case of new * * * sensors, it will still be necessary to demonstrate that the new physiological responses being measured actually correlate with attempts at deception.

C. RESEARCH IN RELATED FIELDS

Research of great potential value to lie detection is being accomplished in closely related fields, such as bioastronautics and medicine. No attempt will be made to summarize these efforts though the existence of several important areas will be noted.

There has been a need to monitor the physiological status of astronauts in space flight and in the experimental program associated with it, e.g., high altitude chambers, human centrifuges, protective clothing, etc. This has led to the development of new, reliable and miniaturized sensors for such responses as the cardiac pattern (EKG), blood pressure, breathing, and body temperature. Because of the need to telemeter the data from the spacecraft to ground observers, means have been developed for digitalizing the data, transmitting it to a remote receiver, and processing it automatically so that it can be read and interpreted in real time by observers on the surface of the earth. Though telemetering such data is not an obvious requirement for lie detection purposes, it provides the means (with miniaturized equipment) to conduct an interrogation under circumstances where it is desired to have the subject unencumbered with wires which restrict his movements.

There is also great current interest in using high-speed computers for better understanding of physiological, neurological, and biochemical processes. Computers make it possible to observe simultaneously many of the complex responses of the organism and to identify the significant parameters of these responses, either alone or in combination. For example, H. V. Pipberger (Mount Alto VA Hospital, Washington, D.C.) has demonstrated that 90 percent of routine electrocardiograms can be diagnosed correctly by computerized data processing equipment. The National Institutes of Health provide about \$18 million in fiscal year 1963 for medical computer facilities; the estimated amount is \$68 million for fiscal year 1964. Thus, means are now at hand to investigate many complex physiological processes on an ongoing, real time basis. This technological capability can readily be applied to improve our knowledge of lie detection by rigorous, systematic study.

8. CONTRAINDICATIONS AND COUNTERMEASURES

The emotional reactions of a person in response to certain but not all questions depend largely upon the rules of behavior being followed by the person. When there are clear, cultural distinctions between right (or truth) and wrong (or lie) attached to each answer (and assuming that the point of the question is understood equally by the interrogator and the subject), the polygraph should prove a valid instrument for most people. It is, therefore, useful to recognize that there may be several situations in which the polygraph could fail:

- (a) When the subject lacks appreciation of the difference between truth and falsity. A habituated liar (or severely disturbed personality) should not be expected to show (or indeed, "feel") emotions due to fear of detection.

(b) When there are differences in the behavioral codes of the subject and interrogator. Such differences may separate people in different cultures, or people of different social (or political) status in the same culture.

(c) When the subject attempts to "beat" the polygraph by controlling his breathing or cardiac response, by suppressing his memory, or by feigning a mental attitude, with or without the benefit of training, to produce such effects.

(d) When the subject has used drugs and, possibly, hypnosis to modify his physiological responsivity.

With such possibilities in mind, a polygraph examination can lead to three undesirable results:

(a) False positives: In which it is concluded that a person is attempting deception, when this is not the case.

(b) False negatives: In which it is concluded that a person is not attempting deception, when this is not the case.

(c) Indeterminate: When the examiner recognizes that he cannot make a reliable judgment about deception or truthfulness.

Among these three categories, indeterminate results need not confuse the examiner because he knows that some additional step, such as a reexamination or a more careful background investigation, must be taken to resolve the uncertainty. Overall accuracy should be increased when the examiner is free to employ the indeterminate category, although this obviously produces fewer resolved cases.

Kubis (1950) achieved a confirmed accuracy of about 90 percent but also made 10 percent inconclusive judgments, a larger fraction than is generally reported. Lee (1953) reports 98 percent accuracy and no inconclusive determinations, while Inbau and Reid (1953) report 95.6 percent accuracy and 4.4 percent inconclusive determinations. Although there are little data to document the errors that actually occur in lie detection, there appear to be some false positives (about 2 percent according to Trovillo (1951) and Lee (1953) and fewer false negatives (but no data appear on this point). In terms of crime, it is believed that some guilty might escape but very few innocents would be punished.

(1) Contraindications to use of the polygraph

Lie detection experts²² point out that a polygraph examination should not be conducted during certain transient states of a individual, such as, for example:

Excessive fatigue.

Prolonged interrogation.

Physical abuse.

Extreme nervous tension.

Evidence of drugs, especially tranquilizers and stimulants.

Sub shock or adrenal exhaustion.

Fear of detection of some other offense not related to this interrogation.

A similar restraint applies when long-term physical or psychological disorders are present:

Excessively high or low blood pressure.

Heart diseases.

Respiratory disorders.

Hypert thyroidism.

Mental abnormalities.

Feeble mindedness.

Psychoses.

Psychopathic personality.

Any of these conditions precludes an effective examination because it introduces into the record response characteristics which are not the result of the examination itself. The professional integrity of the examiner would require him to refuse to examine individuals in whom such conditions are known to be present because an adequate examination could not be conducted. If an examiner did not know this in advance, he might detect certain unusual characteristics in the record which could lead him to terminate the examination as inappropriate under the circumstances. Various test procedures, such as repeating a test, or the "peak of tension" technique are intended to guide and alert the examiner to such effects. One obvious difficulty is that some of these conditions are not readily apparent (e.g., psychopathic personality or presence of drugs) or may not be known at the time of the interrogation. Another is that some interrogators believe they can handle every kind of case (they use the phrase "break

²² Inbau and Reid (1953), pp. 64-99; Lee (1953), pp. 126-132.

a case"). Restraint in recognition of one's ignorance about the possible presence of such conditions depends, ultimately, on the professional standards and integrity of the examiner since no control exerted outside the examination room can ever be entirely effective.

(2) *Can one beat the polygraph?*

If the aforementioned conditions represent natural limitations to the accuracy of the polygraph, we may now consider whether it is possible to fool a polygraph examiner. The machine itself cannot be fooled because it simply records a pattern of responses to a series of questions while it is the examiner who interprets their meaning. What, then, can a person do deliberately to avoid the appearance of deception or to mislead an examiner? What follows consists of a series of conjectures and the preliminary results of one experiment.

The experiment which deals with this question was performed by Kubis (1962) and has been described above. Though only preliminary data are available, they show that by tensing the muscles of the feet or by use of self-exciting images, test subjects could drop the accuracy of examiners in guessing a number from 75 to 80 percent to 20 percent. In 55 to 70 percent of the cases, it was possible to direct the attention of the examiner to a decoy number instead of the previously selected number.

Experiments on human conditioning add a significant note. In a recent review entitled "Does the Heart Learn?" Shearn (1961) concludes that both the form of the electrocardiograph cycle and the heart rate may be conditioned in accordance with classical rules. The technique is illustrated by an experiment of Petrova:

"An auditory stimulus (whistle) was combined with intravenous injections of nitroglycerin. Because the act of injecting the fluid would act as a conditioned stimulus, its effect was extinguished with repeated intravenous injections of normal saline. The whistle, on the other hand, was always sounded after the nitroglycerin had been injected (but before the effect of the drug was manifest). After about 100 pairings of the whistle and nitroglycerin, the whistle presented alone produced changes typical of those elicited by the drug (accelerated heart rate, decrease in QRS voltage, and augmented P and T waves)" (p. 452).

It is known that alterations in the breathing cycle can affect the cardiac response, thereby providing a means of conditioning the heart without intermediary use of some drug (Huttenlocher and Westcott, 1957). Preliminary experiments suggest that a person can learn to alter his GSR with the aid of a meter which permits him to observe the magnitude of his responses. There is no doubt that the EEG can be modified by means of conditioning (Ellingson, 1956). Gerard (1951) reports that alpha waves of the EEG, which normally disappear when a bright light shines on the eye, do not disappear when the observer deliberately pays no attention to the light. However, these facts do not imply that the EEG could be manipulated with the dexterity required to accomplish deception; not enough is yet known about the value of the EEG for use in the polygraph. Polygraph examiners know that a person who moves and squirms during an interrogation can alter the responses shown on the record; this effect would influence the interpretation of the over-all record if it could be accomplished systematically without the examiner's knowledge.

It is possible that a person could be taught through a series of carefully arranged conditioning experiments to bring some of his autonomic responses under his direct control. Lacey (1958c) has demonstrated that each person uses his body in a unique way to express his own emotional responses; this is the result of normal training and maturation. Kubis (1962) has demonstrated that autonomic responses can be influenced through simple instruction without formal conditioning. There can be no doubt that some degree of manipulation is possible; however, in order to accomplish deception, a person would have to learn to suppress or to excite his physiological responses in a pattern adequate for his purposes.

In recognizing the feasibility of such an attempt, we do not know whether training could be accomplished with sufficient elegance to become a useful device for an enemy agent. One method would be to learn to deaden all responses, so that no pattern would be discernible in response to significant or nonsignificant items; another method would be to overrespond to all items with similar effect. Though an examiner might be led to make an indeterminate conclusion in such cases, he might also be alerted to this unusual circumstance. It would be much more effective if a person could deliberately react to nonsignificant items and deaden his response to significant items; but in this case, he would also have to

know what type of response to each question would be most likely to create an impression of knowledge or lack of knowledge about the events of interest to the interrogation.

Since the control of autonomic responses must be regarded as feasible, research is required to explore its implications for our lie detection technology. The examiner will not be helpless because new indicators can be added to the polygraph system to observe response systems which may not have been trained. Since enemy agents would also learn about new indicators, this could lead to a cycle where it may become necessary to add still newer indicators and drop older ones from time to time. But before proceeding that far, it is useful to know the extent to which training is possible, whether the current indicators are sufficiently sensitive to remain effective despite training and, then, what additional indicators are most likely to provide useful adjunct information.

It is also of interest to know if drugs or hypnosis can be used to influence a polygraph examination, both from the viewpoint of the person who takes an examination and from that of the examiner. Fortunately, the effects of drugs and hypnosis on interrogation have been reviewed recently on behalf of the Air Force and are described in an excellent book (Biderman and Zimmer (1961)).

A person about to be examined on a polygraph could take a drug, perhaps a tranquilizer, to moderate his responses. There is a danger to him in that the action of the drug is not selective—it would affect many of his responses. A flat record is unusual and tends to attract the examiner's attention; the presence of depressed responses suggests that a drug may have been used. The use of a drug, if suspected, is easily circumvented by detaining a person for a retest after the drug effects have worn off, and prolonged examination and retest is the rule in any nonroutine polygraph interrogation.

Gottschalk¹³ says:

"There is a possibility that tranquilizers could be used by an examiner with selected personnel who are highly agitated and disturbed, and who might give information they prefer to withhold in return for the tranquillity they experience with such a sedative. Under the influence of this drug, the less emotionally upset informant might find that he can better master his anxieties and keep his resolve to remain silent. These are all speculations which require testing and experimentation. . . .

"The popular meaning of being 'drugged' or 'doped' implies that an individual in this state has lost control over his actions and that society will not hold him responsible for them. When the transmittal of information is likely to induce guilt in the source, the interviewer can forestall some of this reaction by the administration of a placebo or drug. In some cases, this will be all that is required to remove the barrier to information transmittal. In the avoidance-conflict between the source's guilt over yielding information and his anxieties over the possible consequences of non-cooperation, the 'inescapable' power of the drug or placebo serves to justify the source's actions to himself."

Whether or not a drug facilitates the interrogator's task, its use provides some people with an acceptable excuse to reveal information and in this sense it could produce useful side effects. Though a drug, such as LSD-25, may make a person more talkative, the interrogator still has the problem of judging the reliability of the information provided through its use since such drugs are also known to incite fantasy, drowsiness, and confusion (Redlich, 1951). To sum it up, though some drugs make a person more talkative, they may also make him more suggestible and less critical, providing nonsense as well as information. There is not, unfortunately, a magic way to the truth.

Orne¹⁴ has reviewed the use of hypnosis in interrogation and arrives at a conclusion similar to that for drugs except that even less is known about hypnosis. The possibility of inducing a trance on a resistant person is extremely doubtful. Hypnosis requires a trustworthy relationship between the hypnotist and the subject and such a relationship does not evolve readily in an interrogation. There is a common (although probably untrue) belief that an individual in hypnosis is not responsible for his actions. If hypnosis can be established in an interrogation (this is not likely) it could, like a drug, be used to relieve a subject of responsibility for his actions and allow him to divulge information he might not otherwise yield. The idea that an enemy agent could be hypnotized to avoid giving indications of deception appears very remote. Again, a more dangerous person appears to be one who practices deception under his own control rather than one who does so with the help of drugs or hypnosis.

¹³ In Biderman (1961), pp. 182-183.

¹⁴ In Biderman (1961), pp. 169-215.

Under AFOSR Contract AF 49(638)-728 on "Hypnosis as a Control Technique," Orne will measure autonomic responses in conjunction with research on personal control techniques for either offensive or defensive purposes; it is too early for any results to be available. Preliminary data from Fort Gordon suggests that hypnosis assists suggestible subjects to "forget" selected incidents.

Thus, there is some reason to believe that a person could be trained to introduce misleading physiological responses on the polygraph. An examiner might be able to counteract this influence by observing response indicators in which such a person may or not have been trained. Clearly, we need to know more about the possibility of such training and how to counteract it. This is equally true of drugs and hypnosis although it appears that it will be more difficult to detect the effects of training than the effects of drugs and hypnosis.

9. RUSSIAN CAPABILITY IN LIE DETECTION

The use of lie detection equipment for security screening naturally raises the question as to whether an enemy agent could take such an examination and not be detected. If such an event occurred within the United States, its consequences could perhaps be counteracted because the polygraph provides only one source of information which could be compared with that from other sources. In screening foreign nationals, however, it is often impossible to collect any background information, in which case the polygraph provides the only data on which a judgment of attempted deception, with all its implications, can be made.

* * * In connection with the trial of U-2 pilot Francis Gary Powers, L. N. Smirnov, Deputy Chairman of the Soviet Supreme Court, was quoted as saying that "such methods as using lie detectors and brainwashing techniques are loathesome to our legal ideals."¹⁸ Smirnov's comment would be more credible without the remark on brainwashing.

Russian capability in technological areas closely related to lie detection is formidable and completely up to date because of their long continued interest in and research on human psychophysiological processes.

Starting with Pavlov, the Russians have studied extensively a large variety of physiological responses of the intact human organism in many different situations involving the effects of learning, drugs, surgical manipulation, and the like. Over a period of 50 years, the method of conditioning has been extended to such processes as human learning, education, social adjustment and abnormal behavior. This method of psychological research was fostered in the Soviet Union because it permitted objective and mechanistic descriptions of behavior while avoiding subjective and phenomenological explanations. This led to the development of a sophisticated technology concerning measurement of physiological processes, the autonomic nervous system and the central nervous system. The Russians have also accomplished important work on the quality and quantity of physiological response when the organism responds to new, as distinct from old, information; this is called the orienting reflex and will be discussed below.

In 1923, A. R. Luria, of the Institute of Defectology, Academy of Pedagogical Sciences, Moscow, employed muscle tremors as indicators of emotional response to judge the guilt of criminal suspects. Though his work is regarded as significant, muscle tremors have not been used subsequently in lie detection work. Luria shifted his interest from criminal interrogation to other areas many years ago. His recent interest centers on the role of speech in the regulation of normal and abnormal behavior.

E. N. Sokolov (1960), of the Academy of Pedagogical Sciences, Moscow, has extended the work of Pavlov in an area called the "orienting reflex," which he reported to an American audience in 1960. The orienting reflex is an unspecific response, common to animals and men, which occurs in the presence of any unusual stimulus, such as an increase, decrease, or qualitative change in a stimulus; it can occur on the stimulation of any sense organ. It can be observed and recorded simultaneously by such response mechanisms as the EEG in the occipital or motor region of the brain, the GSR, muscle tension, eye movement, respiration, and the like. The magnitude of these responses diminishes upon repeated presentation of the stimulus, essentially disappearing after 10 to 15 presentations.

¹⁸ D. G. Brennan (1961), p. 356.

The orienting response is a reaction to novel information (in the information theory sense) and not to the stimulus as such; it is not a conditioned response. Its significance to lie detection is that if a question is routine, orienting (i.e., the magnitude of physiological responses) should be minimal and rapidly disappear. If a question is novel, orienting should be strong and persistent. In other words, a truthful response should result in a minimal orienting reflex. A falsification requires decision, choice of words, a judgment designed for self protection and, in this case, the orienting reflex should be prominent and reinforced.

In summary, the U.S.S.R. must be regarded as highly qualified in the technology of lie detection, at least equal to that of the United States and Soviet scientists are fully competent to accomplish in this area anything that we can do.

10. KNOWLEDGE DETECTION FOR ARMS CONTROL AND POLITICAL PURPOSES

An unusual proposal to use lie detection as a means of inspecting an arms control agreement was first made in January 1956 by Lewis C. Bohn (1960, 1961) in a RAND memorandum; in later versions, he calls this idea "knowledge detection." Another suggestion, called "truth detection" has been made by Gerard (1961) that the polygraph technique be used to demonstrate truthful intent in international political affairs:

"The proposal is simply this: all key men, speaking officially for their country in private negotiations or public addresses, subject themselves to lie, or better, truth detection procedures administered by technicians from an opposing country or from the UN. More positively, when a statesman wished to convince the world that he was making a true statement he would subject himself to truth detection."

Both of these ideas assume that additional knowledge about the polygraph would increase our willingness to use it for purposes beyond those of conventional interrogation. Bohn recognizes that the accuracy of lie detection is not known and that claims for its validity may be suspect. Bohn and Gerard believe that a carefully designed, full-scale research program is desirable because it may improve the reliability of the lie detection procedure, reduce the need for subjective judgment in interpreting the results, and increase our understanding of the underlying physiological and cultural processes which influence its accuracy.

The remainder of this section is concerned solely with the application of lie detection to arms control inspection because of its possible military value. It is important to know the true reliability and validity of the lie detection method; while higher values are desirable, the actual values are not critical except that they would influence the number of people who would have to be interrogated to achieve any desired level of statistical confidence and, naturally, establish an upper bound to the value of this method.

American participation in an arms control agreement with the U.S.S.R. requires reliable assurance that no attempt is being made to violate the agreement. This assurance can be accomplished only by direct physical inspection of weapon delivery systems, fissionable materials, factories, test sites, and the like. The categories of information which are required to make an arms control agreement acceptable are described in Frisch (1961). The history of our negotiations with the Russians provides little reason to believe that they would accept on-site inspection on a scale required for reasonable assurance of compliance with an agreement. At one time they proposed a limited amount of such inspection, which we regarded as inadequate; since then their position has become even less cooperative.

Knowledge detection, assuming improved lie detection methods are feasible, provides a means around this impasse and, in certain respects, provides additional capability to the concept of inspection. Knowledge detection does not necessarily require inspectors to travel all over the U.S.S.R. Knowledge detection requires only that access be afforded to selected individuals who, by virtue of their positions as key scientists, military or political figures, would be in a position to know about current activities in such critical areas as troop movements, weapon developments, nuclear tests, and the like. Most of these people are identifiable and therefore an agreement would provide that some proportion of them could be interrogated regularly, probably on a random basis. Evidence from such interrogations that a violation may have occurred would point to the need for an on-site, physical inspection at a particular location or activity. Thus, there could be fewer physical inspections without reducing our confidence in the degree of compliance with an agreement.

Nonphysical inspection would also potentially make available a type of information beyond the capability of any physical means of inspection. This lies in the area of intent and future plans which, in general, produce limited physical

evidence. It also affords some means of knowing about technological developments for future weapons with physical characteristics beyond the detection capability of an inspection system set up before knowledge of their existence was available; or of tests conducted at remote times and places below the sensitivity level of an existing detection system.

There are some limitations to physical inspection. It is very costly, requires some selection among all the possible events of interest, and can only respond above the threshold of those sensors which have actually been installed. On the other hand, knowledge is pervasive and is not bound by time or place.

Bohn and others¹⁷ who have explored this idea recognize that it has advantages and disadvantages. The characteristics of a nonphysical inspection scheme would have to be evaluated carefully to determine whether it has a useful role, among many means of inspection, in providing the information necessary to assure us that possible military and political agreements are not being violated.

Knowledge detection is proposed by its supporters as an adjunct to and not a substitute for physical inspection. There are formidable questions as to whether lie detection would work when used by people of different cultures; or whether the records of key leaders would show indications of deception when they deliberately mislead foreigners in accord with their country's interest, as they see it. Finally, key leaders need not lie if provisions are made to keep them ignorant of significant developments. There is no evidence that the U.S.S.R. would find nonphysical inspection any more acceptable than physical inspection or that an agreement with them could be reached in which it was one of the means of inspection.

To some extent, the use of lie detection in search of knowledge among a group of people is a simpler problem than whether a particular individual has committed a crime. In the latter case, extremely high reliability is required. In the former, we are searching only for leads which become significant when observed in several people and which alert us that a particular type of event may have occurred and that, therefore, a particular physical inspection may become necessary. Detection of knowledge among many people lends itself, conceptually at least, to the use of standardized, pretested questions, simultaneous testing of groups of people, multiple recorder, and automated data processing.

For purpose of the present paper, however, it is sufficient to recognize that additional research in lie detection is desirable primarily for the use to which it is now put in our own military establishment. Research and development for such purposes will also provide the information required to apply lie detection to other uses that may arise in the future, of which arms control inspection is a prime example. The question as to whether or not we should consider it for such use obviously requires that we know more about the capabilities of lie detection, the problems faced in its employment with individuals in a society competitive with our own, the sampling procedures which would be required and the value of the information derived by its use in comparison with the cost of operating such a data-gathering system. These questions can only be answered by supporting additional research and development on these topics.

11. THE INTERVIEW TECHNIQUE IN LIE DETECTION

One could write a treatise on lie detection by considering the interview technique to the neglect of the polygraph instrument. Lie detection requires the use of a delicately controlled interview in order to understand the instrumented responses which are obtained. The intimate combination of interview technique and polygraph technique is recognized by polygraph examiners and the key writers on lie detection. In describing the interview, attention is directed to the use of "relevant-irrelevant" type questions, "peak of tension" procedures, control questions and the need for repeating a test; there is clear concern with the importance of a well-controlled interview. Learning how to interview properly comprises a substantial portion of the training of a polygraph examiner. This probably accounts for the preference for polygraph examiners who have previously qualified as military investigators.

Prior to an examination, the examiner is supposed to prepare his questions in a form which permits only "Yes" or "No" answers. Before the polygraph is attached, it is general practice to review with the person the precise questions to be asked to make sure that they are completely understood. A polygraph examination is severely contaminated if a person does not understand the

¹⁷ Melman (1958), pp. 39-44; Milburn et al. (1960); Bernard T. Feld in Brennan (1961), pp. 317-332; Jerome B. Weisner in Henkin (1961), pp. 112-140; Jay Orear (1961).

questions being asked or if he is responding emotionally to embarrassing or shameful features in these questions not known to the interrogator. Every reasonable attempt must be made to reduce such extraneous influences; the meaning of the questions must be clear and obvious; the manner of the examiner must be neutral. There is no need to emphasize further the obvious significance of the interview upon the test and we may turn directly to the problems it poses as to the accuracy of the lie detection procedure.

Though the technique of an interview is an art rather than a science, certain of its aspects are amenable to standardization and evaluation and it is likely that interview techniques within a multiofficer unit could be reasonably standardized. Nevertheless, the reliability of the interview associated with the polygraph examination has never been statistically evaluated. Yet, it is known from other studies that the reliability of interviews (agreement between different interviewers in reporting identical material) varies widely; typical values range from 40 to 80 percent (Hyman, 1954). It is entirely possible, and probably desirable, to improve the content, format of questions and the order in which questions are presented in the lie detection interview. The problem with any single question is to determine whether alone or as a consequence of the order in which it appears it presents ambiguous unclear meanings to the recipient—not to the examiner. This can only be determined by an objective method, similar to the procedure used in the development of any standardized intelligence or personality test. The method is tedious but quite straightforward. It involves collecting all the answers that may be given in response to any particular form of asking a question, including the order in which it is presented. Since ultimately only "Yes" or "No" answers are desired, the real problem is to determine what the subject had in mind with each answer. This preliminary procedure is required to assure us that all of the characteristics of the questions employed in an interview are, in fact, known. There is no evidence that this has ever been done in lie detection or that advantage has been taken of techniques that are available for dealing with this problem. This is not to deny, of course, that the importance of the interview has been recognized or that efforts have been made to improve it on an intuitive, but not an objective, basis.

A standardized lie detection interview would apply primarily to situations which permit a routine procedure, such as in interrogation based on a personal history statement. It would in effect, provide an "optimized" interview; it would standardize the interrogation and assure us that all persons are dealt with in the same manner. It would reduce the variability due to the personal technique and competence of the examiner. It would permit comparison of an individual's responses with that of the group. It would provide a basis for training polygraph operators.

Another limitation to an interview is that the personal manner of the examiner can easily affect the outcome even if completely standard questions are used. Only anecdotal evidence is available on this point but it is obviously a matter of great importance. In psychotherapy, we know that a patient is urged to move from one therapist to another until he finds one in whom he can confide; the therapist is responsible for pointing this out if it is not otherwise obvious. Similar responsibilities concerning the mutual compatibility of the client and

Polygraph examiners acknowledge the existence of this problem and attempt to deal with it in a variety of ways, such as by supervision, attempting to "match" the examiner with the subject, observing the interview through a one-way mirror and/or over an intercom, and by encouraging an examiner to excuse himself from any interrogation in which he feels he is being ineffective. Any effort to act in accordance with such rules must be highly regarded. Here, again, the question is whether such restraints are actually adhered to in practice. Doubtless, abuses are likely to creep in when the staff are overloaded, when there is inadequate supervision or when an examiner works alone.

It would be relatively easy to determine objectively the magnitude of such influences by comparing the effectiveness of different examiners with a carefully selected sample of similar cases. An interesting idea, which is being employed on an experimental basis in psychotherapy, is to observe the emotional responses of the therapist to the patient during interviews. This notion could be adapted to research on the lie detection interview.

It would also seem highly desirable to create impartial boards of professional overseers to establish standards to guide and help the examiner as well as to assure the Government that thoroughly professional practices are being observed. It is believed that no such professional supervision and review is presently in effect anywhere in the Government.

12. SELECTION AND TRAINING OF POLYGRAPH EXAMINERS

The selection and training of polygraph examiners within the various branches of the Government proceeds along similar lines; the differences are not significant.

It is preferable, but not mandatory, that a prospective examiner be a college graduate; in some agencies, one to two years of college is acceptable. It is desirable in all agencies, and mandatory in some, that the candidate be a qualified field (or security) investigator. The ability to speak one foreign language is required for field examiners in one organization. All examiners are civilians in the Navy and military in the other services. It is highly desirable that a candidate be mature, poised, intelligent and emotionally stable but no formal measures are in effect to help screen people for these traits, such as a psychological assessment test and/or an interview with a psychiatrist. In at least one organization, an applicant's record is evaluated by a committee of senior polygraph examiners before he will be accepted for training; in another organization, the applicant is interviewed by a board of five senior examiners whose independent judgments are a basis for acceptance.

Formal training ranges from 6 to 10 weeks at full-time schools. Most curriculums appear to be derived from the Keeler Polygraph Institute and include operation of the polygraph, interrogation procedures, record interpretation, legal, medical and psychological aspects, practice, and casework.

After formal training, some effort is made to supervise the work of a novice examiner but no consistent practice is discernible. In one organization, the examiner is supervised for 18 months after schooling before he is permitted to examine a case without supervision in the field.

There is no reason to doubt that a reasonable and conscientious effort is made to select and train polygraph examiners within the limits imposed by the competition for qualified personnel and the training facilities available to military and governmental organizations. An attempt to improve the professional status and quality of this operation would afford an opportunity to review the curriculums, selection policies, training procedures, and facilities provided for this purpose. It is believed that increased support and recognition would prove helpful.

There is room for improvement by providing for psychological assessment of candidates before they are qualified. Since the examiner's manner and bearing must affect his ability to conduct an interrogation, it is surprising that an overall psychological evaluation which would include a battery of psychological tests and a psychiatric interview is not used to screen prospective examiners. An incidental value of this step would be to provide data for improving selection procedures in the future. One would initially try to select candidates with the psychological characteristics of the effective examiners and to reject the others; and confirm the effectiveness of such procedures as experience builds up. It may also be desirable to review examiners for psychological suitability every year or two after they are on the job, since changes in psychological stability are not unknown in stressful occupations.

There are also some civilian training facilities. The Keeler Polygraph Institute (Chicago) and the National Training Center of Lie Detection (New York) provide 6-week training sessions which have been attended by police trainees, Coast Guard, and a few private operators. The National Training Center sponsors 3- and 5-day work conferences for polygraph examiners which have been attended, in addition to those mentioned above, by representatives of the Armed Forces (excluding the Navy), the Treasury Department, and employees of manufacturing or sales companies. Courses are also provided at such colleges as the University of California, Washington State College, New York University, and San Jose State College (California). At one time, C. H. Stoelting, a respected manufacturer of lie detection equipment provided a 6- to 9-month correspondence course supplemented by 2 weeks of apprentice training at a police department. Several attempts to establish professional qualification standards and a certification program have led to the formation of the American Academy of Polygraph Examiners, the Board of Polygraph Examiners (now merged with the American Academy), the Academy for Scientific Interrogation, and the National Capitol Polygraph Association (organized recently in Washington, D.C.) There is no way, however, to stop anyone with \$1,000 from buying a polygraph and setting himself up as an examiner in civil life.

13. GENERAL DISCUSSION

There is a remarkable absence of objective information concerning lie detection and the polygraph. No explanation for this state of affairs appears; it is

ible other than a lack of appreciation for the statistical, professional, procedural and technical questions which abound in this area. Chronic shortages of personnel and a failure to assign qualified statistical and research personnel to polygraph units must have contributed to but does not explain the absence of studies on the effectiveness of lie detection programs. About 200,000 examinations have probably been performed with the polygraph, but there is not even a reliable summary of the number of tests accomplished within the Government. There is no useful residue of this experience to help identify the strong and the weak features of our present procedures or to tell us what we must do to improve them. Though there is no reason to doubt that the lie detector "works," we do not know whether the security and criminal interrogations would be just as effective as they appear to be without the polygraph device.

The experts themselves express divergent views:

"Although the present-day instrument can assure almost 100-percent accuracy in detecting deception, the long history of constant search for improvement continues. The day is not far off when it may be said with complete accuracy: 'You can't beat the machine'" (R. W. Inman in "Truth: The Polygraph Story," current catalog of Associated Research, Inc., producers of the Keeler Polygraph, no date).

"The best advertising is our ability to get at the truth more often and more accurately than any other known method but claims of 100-percent success are an insult even to the casual intelligent observer" (Ansley & Weir, 1956, p. 2).

"Among polygraph examiners, the machine itself is credited with 10 percent of the success of a polygraph interrogation; 90 percent or 95 percent of the interrogation is dependent upon the ability, sincerity, and training of the examiners using this piece of equipment" (R. W. Inman in Ansley & Weir (1956), app. II, p. 18).

The repetition of numbers which have no objective basis has created an impression of knowledge that need no longer be tolerated.

There has been more concern with the problem of conducting polygraphic interrogations than with determining whether the polygraph is a valid instrument in lie detection. Polygraph operators have had the responsibility of doing the best they know how with the facilities available to them. They have not had the opportunity or the detachment required to assess their own activities. They must, in fact, be complimented for doing a conscientious job without the support of objective evaluation, research and development provided in many other programs.

Improvement of our lie detection capability will require a coordinated research and development program and the development of professional standards in the practice of polygraphy. We will discuss these two steps below.

First, research and development in equipment and test procedures are required to improve our capability in lie detection. This research program should have the support of a technical advisory committee consisting of competent and respected scientists who are not committed professionally to the use of the polygraph device, together with liaison from the operating agencies. No conceptual problems are thought to exist in the formulation of a research program and it is believed that an expanded program will produce useful results.

No lie detection research and development program is currently in existence. The several studies which have been identified receive insufficient support (about \$100,000 a year) to provide the effectiveness we require in our lie detection capability. Except for the work of Kubis and Zimmer, most of the "research" is aimed at improving various features of already existing equipment. This will not enlarge our understanding of lie detection. Work of the type performed by Kubis has been conducted on a small scale (\$25,000 per year) and should be enlarged to at least \$100,000 per year. This is also true of Zimmer's work on computer data processing of physiological responses to improve lie detection.

Research and development should be expanded to a level of about \$500,000 per year for a period of 3 to 5 years. This will permit a significant increase in our knowledge of the physiological, behavioral and methodological problems associated with lie detection together with a modest improvement in sensors, instrumentation and experimental facilities. It would provide the basis for a judgment as to the probable utility of a computerized lie detection apparatus but not the funds for such a development. Competence and resources for conducting an expanded R. & D. program in the psychological, behavioral, and

methodological aspects of lie detection exist in the universities and research organizations; and in industry for the development of new equipment.

However, research and development does not possess magic properties. It is not likely that a new sensor * * * or a computer program will tell us whether a person is lying. Some research must be undertaken simply to determine whether additional sensors can improve the lie detection procedure. There is a need for experiments with, perhaps, six to ten sensors to determine the contribution each physiological indicator makes, alone and in combination, to the accurate estimation of deception by objective—that is not subjective—means. This has never been done and it is a basic step in an improvement program. Another problem is to develop a series of test situations (from simple and artificial to complex and real) in which experiments on lie detection can be performed with a reasonable expectation that the conclusions will apply to real life situations. With these considerations in mind, a research and development program based on the following guidelines should be undertaken.

A. Study the taxonomy of deception to identify the various types of deception that may exist and the types of responses that might be present in interrogation situations.

B. Develop record reporting procedures which will permit a continuing assessment of the effectiveness of lie detection. Examine the possibility of using already existing records for the purpose of evaluation. The purpose of such studies should be to determine the validity of lie detection in day-to-day operations in situations of interest to the Department of Defense.

C. Determine the reliability of the current polygraph technique by comparing the results of different examiners working independently on the same real life case material.

D. Support laboratory studies in which simultaneous recordings are made of six to ten physiological indicators to determine the reliability of measurement and the relative contribution of each indicator, either alone or in combination, to the validity of lie detection. The following indicators are suggested:

Breathing pattern.

GSR.

Heart rate.

Plethysmograph.

Blood pressure:

Systolic.

Diastolic.

Skin temperature.

Pupillary response.

Muscle tension potentials.

This research should also examine the feasibility of on-line data processing of multiple indicators to yield a product(s) useful to guide the examiner during the interrogation.

E. Develop new equipment in support of laboratory studies:

* * * Sensors: Because of recent developments in medical electronics and bioastronautic many new sensors and transducers are now available to replace those in present use. The new sensors should be adapted to meet lie detection requirements in order to improve reliability of measurement and convenience of use. Some new sensors will also be required for experimental purposes involving the additional physiological indicators noted above.

F. We must study the possibility that prior conditioning, drugs, or hypnosis, could be used to introduce spurious effects into test records and the steps that should be taken to detect and counteract such influences.

G. The possibility that individuals exhibit unique patterns of autonomic response should be explored to determine whether a preliminary part of each examination could be directed to identify the indicators in which that individual is more likely to respond.

H. Interview procedures associated with use of the polygraph should be evaluated to insure that the content, form, and order in which questions are used contribute to the maximum possible extent to an effective interrogation.

I. Applied research directed toward specific applications of the polygraph (e.g., screening refugees from Cuba, East Germany, or North Vietnam, or for inspecting an arms control agreement with the U.S.S.R.) should be undertaken to identify the technological and procedural problems which must be solved in order to interrogate individuals in foreign languages, foreign cultures, different status systems, and with divergent political allegiances. There are, obviously,

wide differences between cultures concerning the situations in which and the purposes for which deception may be attempted as well as what constitutes mutually acceptable evidence to people of different cultures that deception has, in fact, been attempted. In these studies, we should examine such problems as the development of standard questions (perhaps given by voice tape), simultaneous testing of groups of people, rapid analyses of data, simplified and transportable equipment, and the countermeasures which might be employed to interfere with such tests.

Second, there is a need to upgrade, standardize, and regulate lie detection activities throughout the Department of Defense. This should be accomplished for the Government as a whole although such a proposal is beyond the scope of this report. Professional guidance of a high order is required to assure us that lie detection is being conducted effectively, to protect the private rights of our citizens, to establish lie detection standards, to support polygraph examiners, to advise the Department of Defense on the general level of performance in this area, and to make recommendations to improve our capability when this is required.

There is a need to establish standard methods for performing polygraph examinations, data reporting, and review procedures, and for the selection, training and certification of examiners. All such standards should be promulgated in a manual of procedures for the guidance and supervision of examiners. Accomplishment of such results will require the support and assistance of polygraph examiners and scientists in the areas of medical electronics, physiology, psychology, and psychiatry, from the civil and military services, both within and outside the Government.

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