Technical Overview

EyeDetect®

The world's first ocular-motor deception test.

EyeDetect®+
Automated Polygraph

The world's first automated polygraph.

Converus
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Converus Inc.
610 S. 850 E., Suite 4
Lehi, UT 84043 USA
+1-801-331-8840
www.converus.com

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Introduction

Most theories of deception detection hypothesize that lying is more cognitively demanding than telling the truth.[1] Deceptive individuals use cognitive resources to inhibit the truth by fabricating a lie, and maintaining its consistency, coherence, and believability over time.

Deceptive individuals may surveil their own behavior and internal state of arousal to monitor whether they are leaking incriminating information, especially during an interrogation or examination[2].

During interrogation, deceptive individuals may also use cognitive resources to observe the behavior of any interviewers for feedback on their believability. Inhibiting truthful responses, maintaining credibility over time, monitoring the interviewer, and self-monitoring for signs of leakage are cognitive processes that require mental effort. Deception requires mental effort, which is measurable physiologically.

Ocular-Motor Changes

Psychologists have long known there is a correlation between increased cognitive load and certain eye behaviors. For example, pupils dilate commensurate with cognitive workload.[3] The pupils would dilate slightly if a person mentally multiplied 17 x 2. By contrast, pupil dilation would be more pronounced if the person multiplied 17 x 31. In the same way, the pupils dilate slightly when a person answers questions truthfully; but when the person is deceptive, the pupils dilate more because of the mental effort associated with deception.

Other ocular-motor indicators of cognitive processes include:

1) Deceptive people blink less often than truth tellers as they process questions answered deceptively.
2) Deceptive people respond faster, make fewer fixations, and spend less time reading and re-reading statements about their own inappropriate behaviors than when answering questions about neutral topics or inappropriate behaviors in which they do not engage.
3) People show greater increases in pupil size when they answer test questions deceptively than when they are truthful. The differences between truthful and deceptive responses are more pronounced when test questions are less complex.

Polygraph and Other Lie Detectors

For decades, the de facto standard in lie detection technology has been the polygraph. Invented in the 1920s, the polygraph has been the only credibility assessment tool to show accuracy rates as high as 89% when used in specific event questioning and 85% in screening tests.[4]

Polygraph sensors record breathing using transducers wrapped around the chest and abdomen, electrodermal activity from sensors attached to the tips of two fingers, and relative blood pressure from a pressurized blood pressure cuff on the upper or lower arm.

Various theoretical constructs have been proposed to explain the differential physiological responses of truthful and deceptive people to the different types of test questions on polygraph tests. Physiological responses load on one type of question or another as a function of truthfulness or deception. The putative psychophysiological underpinnings of the responses include attention, conflict, conditioned response, and fear of detection. No single explanation is sufficient to account for all effects. Despite the lack of consensus about specific mechanisms that produce the physiological response, emotional processes play an important role in polygraph testing, especially in field settings where there may be serious consequences to the individual if they fail the test.

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[1] Johnson, Barnhardt, & Zhu, 2005; Kircher, 1981; Vrij, Fisher, Mann, & Leal, 2000.
[2] Kircher, 1981.
[3] Kahneman & Beatty, 1966.
[4] Meta-Analytic Survey of Criterion Accuracy of Validated Polygraph Techniques, 2012, table 2.

In recent years, several new cognition-based tests for deception have been developed, all of which are generally based on the notion that lying is cognitively more demanding than telling the truth. Tests based on the concept of mental workload may be predominantly cognitive. However, these tests likely also include an emotional component, just as polygraph techniques include a cognitive component.

Ocular-motor Deception Test

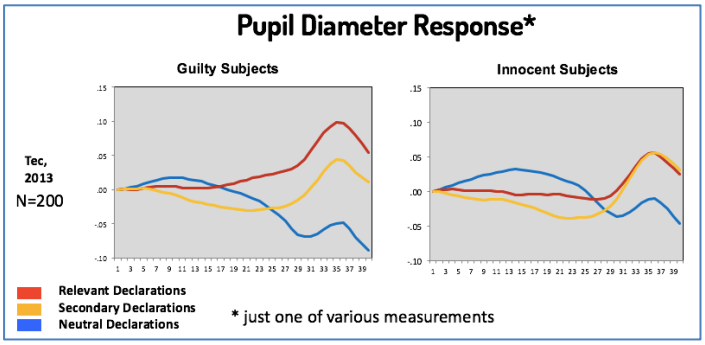
The concept of detecting deception based on eye movements while reading text was first conceived in 1992 by Dr. John Stern at Washington University in St. Louis (Baker, Stern, & Goldstein, 1992). That effort was largely unsuccessful, but the idea was revisited in 2002 by two psychologists from the University of Utah, Dr. John Kircher, a psychophysiologist and pioneer in deception detection, and his colleague Dr. Doug Hacker, an educational psychologist with expertise in the psychology of reading. They were joined by two cognitive scientists, Dr. Dan Woltz and Dr. Ann Cook, as well as renowned polygraph expert Dr. David Raskin. This group and their graduate students conducted research on ocular-motor methods for detecting deception for more than a decade.

Kircher, the lead scientist, was co-inventor with Raskin of the computerized polygraph in 1991. Both are recognized polygraph and deception detection experts. Kircher has published more than 100 scientific articles and reports related to credibility assessment. He has consulted with, and conducted research on, deception detection for the U.S. Department of Defense, National Science Foundation, CIA, U.S. Secret Service, National Institute of Justice, Department of Homeland Security, National Science Foundation, National Research Council, Royal Canadian Mounted Police, and many police departments.

Initially, the science team reviewed existing theories discussing the effects of deception on eye and reading behavior. Then they devised experiments to evaluate a variety of ocular motor responses in cognition-based exercises to determine if a correlation existed.

After nine years of research, their findings were published in 2012 in a peer-reviewed article entitled, "Lyin' Eyes: Ocular-motor Measures of Reading Reveal Deception."[5] In this seminal study, subjects were randomly assigned to either a "Guilty" group that committed one of two mock crimes or they were assigned to an "Innocent" group that learned about the crime after-the-fact. Subjects completed a computer-administered questionnaire that used True/False statements about their possible involvement in the mock crimes. Subsequent experiments manipulated the incentives to pass the test and the difficulty of the True/False statements on the test.

In these experiments, guilty participants had increased pupillary responses to statements answered deceptively. In addition, guilty participants spent less time fixating on, reading, and rereading test statements than participants who answered truthfully.



These various ocular motor behaviors were optimally weighted in a logistic regression analysis. Logistic regression combines one or more variables in a data set to predict a binary outcome, such as truthful or deceptive.
Findings from these and subsequent studies indicated that discrimination between guilty and innocent groups improved when there were greater incentives to pass the test and the test statements used simple syntax. These findings suggested that two cognitive processes are involved in deception: 1) vigilance and 2) strategy; and these processes are reflected in ocular motor and behavioral measures.

[5] "Lyin' Eyes: Ocular-motor Measure of Reading Reveal Deception," Journal of Experimental Psychology: Applied, 18(3), 301-313. September 2012.

The science team's efforts gave birth to the Ocular-motor Deception Test (ODT), a cognition-based test that uses ocular-motor measures of cognitive effort, including some based on reading behavior. Psychologists have found that pupil size correlates with performance on a wide variety of cognitive tasks. Pupil size correlates not only with cognitive effort but also emotional arousal[6], which probably plays a role in all tests for deception[7].

Automated Polygraph

In response to requests from customers around the world and due to government regulations or statutes requiring the use of traditional polygraph metrics in deception detection testing, Converus developed a new technology that combines ocular-motor testing methods and existing polygraph solutions. The original premise was to combine the two most accurate lie detectors in the world into one solution, if possible.

The solution, known as EyeDetect+, was to first administer an automated polygraph test and then follow it with an ocular-motor deception test. In both phases of this hybrid protocol, a computer introduces the test topics, presents the test questions, and scores the data. This has the advantage of limiting interactions between the examiner and the examinee and possible adverse effects of examiner bias or fatigue on test outcomes.

In addition to automating the administration and analysis of the polygraph phase of the test, the Converus Team replaced the cardiograph with a less invasive alternative. The cardiograph is a recording of changes in the pressure of a partially inflated blood pressure cuff on the upper or lower arm that correlates with changes in relative blood pressure. However, after a few minutes, the cuff becomes uncomfortable and must be deflated to restore circulation to the lower arm.

Converus considered a variety of alternative technologies to eliminate the blood pressure cuff and settled on Pulse Transit Time (PTT). PTT is the time it takes a pulse wave to travel from the heart to a measuring point in the body, in this case the finger. PTT has been found to vary inversely with changes in blood pressure (Geddes et al., 1981; Obrist et al., 1978; Obrist et al., 1979), and changes in blood pressure are diagnostic of deception in polygraph tests (Podlesny & Kircher, 1999).

Dr. Andrea Webb explored the possibility of using PTT for lie detection in her master's thesis in 2006. In Dr. Webb's research, a discriminant function that included PTT was as valid for discriminating between truthful and deceptive groups as was a function that included the cardiograph. In addition, the cardiograph did not improve the accuracy of the test when added to a discriminant function that already included PTT. These findings suggest that PTT may be used in place of the cardiograph for detecting deception.

By replacing the blood pressure cuff with PTT, the test can include more questions in each session than a traditional polygraph. More questions produce more measurements of physiological reactions, and the additional measurements should improve the reliability and accuracy of the test.

EyeDetect+ derives PTT from the electrocardiogram (ECG) and photoelectric plethysmograph (PPG) sensors, which attach to the wrists and fingers of the examinee. This new solution eliminates the need for the blood pressure cuff and is less invasive. EyeDetect+ tests take between 20 and 45 minutes.

EyeDetect+ is automated, objective, standardized, and capitalizes on measures from two technologies that have been scientifically investigated and found to accurately discriminate between truthful and deceptive individuals. A computer administers the test and collects and analyzes the physiological and behavior data. In addition to speed and reliability, automation can reduce sources of error such as examiner bias or fatigue. Whereas the polygraph relies heavily on emotional reactions to test questions, the ocular-motor test depends on differential cognitive load. Together, the polygraph and ocular-motor test phases provide different psychological perspectives on the examinee's deceptive status. Although EyeDetect+ borrows heavily on polygraph techniques and measures, it removes a source of discomfort for examinees by replacing the traditional cardio cuff with a less invasive measure.

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[6] Bradley, Miccoli, Escrig & Lang, Psychophysiology, 2008 July; 45(4): 602-607.

[7] Kircher, 1981; unpublished doctoral preliminary exam, Department of Psychology, University of Utah.

Lab and Field Study Results

In 2014, EyeDetect was made commercially available. Lab studies conducted over the previous decade provide estimates of mean accuracy of approximately 85% for the Relevant Comparison Test (RCT) protocol. In 2016, Dr. Kircher and his colleagues conducted field studies with the support and assistance of three groups in the Mexican federal government and published new findings that showed the mean accuracy of ODT to be 86% for field screening tests using the RCT protocol. The data were published in December 2016 in the European Polygraph Journal.

In late 2018, Kircher and Raskin reviewed field data on a small sample of tests using the ocular-motor Directed Lie Comparison (DLC) test protocol, which is primarily used for diagnostic or single-issue testing. The mean accuracy of the DLC test was over 90%. However, because the field cases were not selected randomly, the observed accuracy should probably be considered a high estimate of the accuracy of the ocular-motor DLC protocol. Another lab study was planned to corroborate the results.

In June 2019, Converus announced the availability of a new testing protocol: the Multi-Issue Comparison Test (MCT). The MCT protocol was developed to allow screening tests with 4 relevant issues. This new protocol was the focus of the dissertation work of Andrew Potts, candidate for the Ph.D. degree at the University of Utah. Andrew worked under the direction of Dr. Kircher. In his lab study, the overall mean accuracy of the MCT was 88%. Dr. Potts' successfully defended his dissertation in April 2020.

In the spring of 2020, Converus announced the availability of a new test: Audio Multi-Issue Comparison Test (AMCT). Converus used lab data to develop this protocol for examinees that cannot read. The other EyeDetect tests require the examinee to read the test questions presented by the computer. To read the test statements, examinees must look at the computer screen where the eye tracker can monitor changes in eye behavior. However, the requirement to read precluded the use of EyeDetect with non-readers. The AMCT is audio-only. The computer uses a synthesized voice to introduce the topics, present the instructions, and ask the test questions. In the lab experiment, the mean accuracy of the AMCT was 86%.

In May 2021, Converus announced the availability of two new test protocols: (1) Hybrid Multi-Issue Comparison Test (HMCT) and (2) Hybrid Directed Lie Comparison (HDLC). Both hybrid tests combine ocular-motor and polygraph techniques and measures. In laboratory experiments, Converus found that the HMCT had a mean accuracy of 91%, and the HDLC had a mean accuracy of 89%.

Citations to research on EyeDetect and EyeDetect+ can be found at the end of this document. There are 19 studies published on EyeDetect or EyeDetect+, and 11 of them are peer-reviewed. The following is a summary of the accuracies published:

EyeDetect	**EyeDetect+**
86% Relevant Comparison Test - RCT 87% Directed Lie Comparison Test - DLC2 88% Multi-issue Comparison Test - MCT 86% Audio Multi-issue Comparison Test - AMCT	89% Hybrid Directed Lie Comparison Test - HDLC 91% Hybrid Multi-issue Comparison Test - HMCT

EyeDetect Software

After the science team published the peer-reviewed study in 2012, computer programmers developed software to administer tests in an automated, standardized, and objective manner. They developed a web-based dashboard to administer and score test results. With this software, credibility assessment testing precision was increased as human error was minimized. There is no examiner bias; the examiner cannot affect the test results. Over time, the software has been improved and updated to add more functionality. In addition, another application called EyeDetect Manager was developed to allow real-time monitoring of examinees during testing.

The EyeDetect software application and web-based Dashboard were made commercially available in June 2014 under the brand name EyeDetect® — the world's first ocular-motor deception test.

Test Formats

The American Polygraph Association considers several polygraph testing techniques validated. Some examples include AFMGQT, CIT, DLST, Federal ZCT, and the Utah technique combined with certain test data analysis models. EyeDetect has introduced additional techniques, and more are being developed. The following is a brief description of those protocols.

Relevant Comparison Test

The first to be developed was the Relevant Comparison Test (RCT). The RCT was originally developed for an automated polygraph screening system by Kircher, Raskin, Gardner, Jewell, and Patnaik in 2001. It was designed primarily as a screening test at border entry points. In the December 2016 issue of the European Polygraph Journal, Dr. Kircher and Dr. Raskin reported that the RCT had a mean accuracy of 86% (89% true negatives and 83% true positives).

An RCT covers two relevant issues. The following is a list of common relevant issues. For each issue, additional clarifying information should be provided in the pretest instructions to ensure the examinee understands the issue.

- ***Stealing*** money, products, equipment, raw materials
- ***Illegal use*** of marijuana, cocaine, heroin, amphetamines, steroids
- ***Serious crimes*** *such as* burglary, robbery, drug manufacturing, domestic violence
- ***Criminal ties*** *to* cartels, gangs, organized crime, other delinquents
- ***Divulging confidencial or classified information to unauthorized persons***
- ***Accepting or requesting bribes***

In addition to a relevant issue of greatest concern, the RCT includes a secondary relevant issue called the comparison issue. Comparison issues must meet the following criteria:

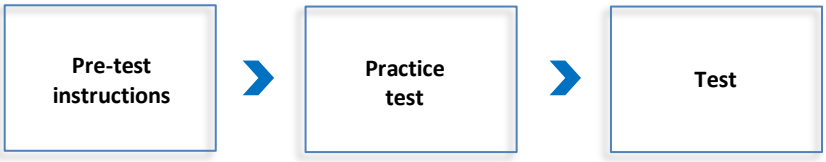
- It must be at least as serious as the relevant issue.
- There must be no crossover with the primary relevant issue (should not be a related topic).
- It must have face validity for the examinee; the examinee must believe the issue is important.
- The base rate or prior probability of guilt must be low (<3%).

Examples of low base-rate comparison issues include terrorism, violent crime, counterfeiting, arms trafficking, kidnapping, and use of date rape drugs.

During an RCT, the examinee responds to a series of true (T) and false (F) statements regarding the issues, as well as neutral (irrelevant) and alpha-arithmetic statements. A high-precision eye tracker records eye movements and reading behavior. The eye tracker takes up to 60 measurements per second and records the data while software records aspects of the examinee's responses to the T/F statements. The computer gathers more than 1 million data points from the eye tracker during the test.

After the test, differences between physiological responses to questions about the two relevant issues are combined according to a logistic regression equation. The output of the equation is the probability of deception, which is used to compute a Converus Credibility Score.

The test includes pretest instructions of the topics. Mind maps could be used in a pre-test interview to present the test concepts to the examinee. Mind maps are graphical representations of the test topics. The pretest instructions are followed by two short practice sessions to familiarize the examinees with the testing process before they start the actual test. After the pretest instructions and practice test, the actual test takes about 22 minutes.



During the test, the computer presents T/F statements on the screen, and the examinee answers using a computer keyboard or mouse. The computer presents over 300 questions during the test. The examinee is given a variable amount of time to answer depending on the statement length, active or passive voice, and negation.

Examinees are forewarned to answer quickly and accurately, or they will fail the test. Examinees that answer too slowly, answer randomly, or attempt to use countermeasures are flagged as non-cooperative and are classified as Not Credible.

During the RCT, the examinee must confirm or deny participation in each disqualifying behavior(s) no less than 80 times each. The examinee also answers 80 general knowledge questions and 48 alpha-arithmetic questions. General knowledge and arithmetic questions are not used to decide if the person was truthful or deceptive to relevant topics.

After the test, the Converus Credibility Score is calculated in less than 5 minutes. The examinee is classified as Credible if the Credibility Score is between 50 and 99 and Not Credible if the score is between 1 and 49. The higher the Credibility Score, the more likely it is that the person was truthful on the test.

A summary report is generated and saved in PDF or HTML format. Test results and scores are available from any web browser that has two-level encryption for access. Each test scored requires a test license.

Directed Lie Test

EyeDetect also supports the Directed Lie Comparison (DLC) test protocol, which is a technique originally developed for the polygraph. The mean accuracy was 90% in a sample of confirmed field cases gathered and analyzed by Drs. Kircher and Raskin in 2018; there is reason to believe that figure overestimates the validity of the DLC test. The DLC test covers one relevant issue. The RQ could address a specific criminal act such as a sex crime, murder, robbery, or theft. Or, it could cover a range of offenses such as drug use or compliance with probation rules.

Reactions to the relevant question are compared to those of the directed lie questions. Directed lie questions ask about minor transgressions to which all are guilty, "In your entire life, have you ever broken a rule?" During the test, the examinee is **directed** to **lie** to this question. The computer informs the examinee that directed lie questions reveal how the eyes react when lying. It informs examinees it will review reactions to the directed lie questions and if the examinee does not react to those questions, they will fail the test.

The DLC test predicts how examinees might react to relevant and directed lie questions. It predicts that innocent people will react more to the directed lie questions to avoid failing the test. Conversely, it predicts that guilty people will react more to the relevant questions because they pertain directly to the matter under investigation.

During the DLC test, the examinee responds to a series of T/F statements regarding the relevant issue, the directed lies, and simple arithmetic. Following the test, the computer extracts features from the signals recorded by the eye tracker and uses a logistic regression equation to combine differences between relevant and directed lie questions and compute the probability of deception to the relevant issue. The Converus Credibility Score is a function of the calculated score, conditioned on the prior probability of guilt.

The DLC test includes a pretest explanation of the topics. That preamble is followed by a practice session to familiarize the examinee with the testing process and ensure that the examinee understands that they must lie to the directed lie questions. During the test, the examinee reads the T/F statements on-screen and answers using a mouse or computer keyboard. The DLC test takes about 15 minutes.

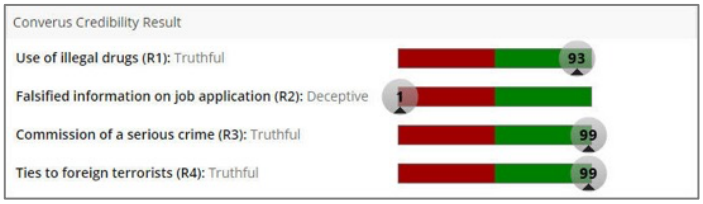
Examinees that take a long time to answer, respond randomly, or are suspected to have applied countermeasures are considered non-cooperative and are classified as “Not Credible.” Credible scores fall between 60 and 99; Not Credible scores fall between 1 and 40. And an “Inconclusive” outcome is given for scores between 40 and 60.

A summary report is generated and saved in PDF or HTML format. Test results and scores are available from any web browser that has two-level encryption for access. Each test requires a test license.

Our observation is that during diagnostic and screening tests with the DLC test, examinees usually obtain scores on opposite ends of the credibility continuum. Most guilty examinees score close to 1, whereas most innocent examinees score close to 99. If eye behaviors and other measures are atypical, the computer indicates that the test is inconclusive. Depending on the circumstances, an inconclusive outcome might warrant a posttest interview or follow-on polygraph exam. Less than 10% of DLC tests are inconclusive.

Multi-Issue Comparison Test

This testing protocol was released in June 2019. Unlike the RCT, the MCT provides a credibility score for all relevant issues. At the University of Utah, doctoral candidate Andrew Potts tested this protocol in a lab study. The results were published in April 2020. In that experiment, the MCT protocol achieved 88% accuracy.[8]



The MCT could address the examinee's participation in target behaviors or activities such as (a) illegal drug use, (b) serious crime, (c) unreported work-related discipline, and (d) ties to a terrorist organization. Often one relevant issue is selected with a low base rate of occurrence, such as terrorism, to serve as a comparison issue.
The computer classifies the examinee as Credible on all issues or Deceptive to one or more issues. It also reports a score for each issue individually. (See image.)

The MCT allows organizations to screen examinees on up to four target behaviors in about 30 minutes. It may refer to any type of target behaviors, such as drug use, sexual assault, criminal history, stealing, association with known criminals, weapons trafficking, falsifying a police application, etc. Ideally, there would be no overlap among the issues covered on the test. For example, sexual assault and criminal history would be partially overlapping issues because sexual assault is a serious criminal offense. In addition to minimizing overlap, it is important to be as specific as possible to minimize, for the examinee, any uncertainty about their actual guilt.
Like the RCT, one relevant issue may be considered a comparison issue that should meet the following criteria:

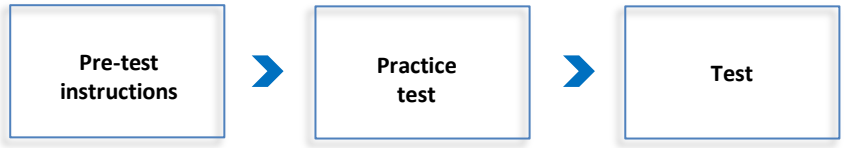
- The issue should address a crime more serious than the other relevant issues.
- The issue must have face validity, salience or believability for the examinee.
- The prior probability of guilt should be low (<3%).
- The issue should not have any crossover (similiarity) to the relevant questions.

During an MCT, the examinee responds to a series of T/F statements regarding the relevant issues. Between repetitions of the test statements, the examinee answers a short series of simple math statements. After the test, the computer extracts ocular-motor measures from the data captured by the eye tracker. It combines the variables with a logistic regression equation to a Credibility Score for each relevant issue.

The MCT test uses an audio-visual presentation to introduce the topics and give instructions. The pretest presentation may include mind maps. The pretest instructions inform examinees that they must answer quickly and accurately or they might fail the test.

[8] Potts, A. (2020). “1, 2, 3 Crimes You’re Out: Ocular-Motor Methods for Detecting Deception In a Multiple-Issue Screening Protocol.” Doctoral dissertation, University of Utah, Department of Educational Psychology.

The pretest instructions are followed by two short practice sessions to familiarize the examinee with the testing process before the test begins. After the pretest instructions and practice, the MCT is administered.



During the test, the computer presents T/F statements serially on the monitor. The examinee reads the statements and answers using the keyboard or mouse. Less than a second after the examinee answers, the computer presents the next statement. Examinees who intentionally delay responding, answer randomly, or are suspected of attempting to use countermeasures are considered uncooperative and Not Credible.

After the test, a Converus Credibility Score is calculated for each relevant issue. Credibility scores range from 1 to 99. The higher the score, the more likely it is that the examinee was truthful about the relevant issue on the test. A summary report is generated and saved in PDF or HTML format. Test results and scores are available from any web browser that has two-level encryption for access. Each test scored requires a test license.

Audio MCT

In March of 2020, the Audio MCT protocol was announced. This protocol uses the same testing process as the standard MCT with one exception: all pretest instructions and questions are presented to the examinee using a digitized voice. No text appears onscreen. This test is intended to be used with examinees that cannot read or have poor reading comprehension.

The following summarizes the characteristics or features:

- Supports up to four RQ in a general screening test
- Lab study results show a mean accuracy of 86%
- Testing time is similar to the MCT
- The examinee answers True/False statements heard aurally.
- A high-precision eye tracker measures and records eye movements.
- Scoring is done by the computer.
- The testing protocol is the same as MCT (pretest instructions, practice test, and test.)
- The examinee uses the computer keyboard or mouse to answer the T/F statements.
- A Converus Credibility Score is calculated for each relevant issue in less than 5 minutes.
- A summary report is available from any web browser that has two-level encryption for access.

Hybrid MCT

In May 2021, Converus introduced the Hybrid Multi-Issue Comparison Test (HMCT). The HMCT is similar to the MCT and Audio MCT. It covers up to four relevant issues, computes a Credibility Score for each relevant issue, and classifies the examinee as truthful to all relevant issues or deceptive to one or more of them.

The HMCT differs from all prior deception detection technologies in that it combines traditional polygraph testing methods with ocular-motor methods. The HMCT has two phases, described as follows:

(1) First phase – computerized polygraph test question format. The computer presents test questions to the examinee with a text-to-speech (digital) voice over headphones while it records electrodermal, respiratory, cardiovascular, and ocular-motor activity.
(2) Second phase - two sessions of the standard MCT question format protocol while recording electrodermal, respiratory, cardiovascular, and ocular-motor activity.

During the HMCT testing format, EyeDetect+ uses a multi-channel physiology recorder to digitize signals it obtains from sensors attached to the examinee. EyeDetect+ records the following signals:

1) Electrodermal activity from gel pads attached to the palmar surface of two fingers.
2) Respiration activity from a strain gauge strapped around the chest or abdomen.
3) Electrocardiogram (ECG) from gel pads attached to each wrist.
4) Peripheral vasomotor activity from a photoelectric plethysmograph (PPG) is attached to one finger.

As previously mentioned, EyeDetect+ uses PTT derived from the ECG and PPG instead of the traditional cardiograph which is less invasive than the cardiograph, alleviates discomfort, and offers more flexibility in test construction by allowing for more questions to be asked during the testing.

During the polygraph phase of the test, the HMCT makes all possible pairwise comparisons of the four relevant issues. In the first half of the first session, the first relevant issue is paired with the second relevant issue. In the second half of the first session, the third relevant issue is paired with the fourth issue. In subsequent sessions, the first relevant issue is paired with the third relevant issue, the first issue is paired with the fourth issue, the second issue is paired with the third issue, and the second issue is paired with the fourth issue. During any given sub-session, examinees focus on only two of the four relevant issues.

In the last two sessions of the HMCT, examinees are advised to read and answer test statements quickly and accurately. These requirements increase cognitive load and improve the diagnostic validity of ocular-motor measures, such as number of fixations, increases in pupil diameter, and blink rates.

Converus conducted a large experiment patterned after Dr. Pott's (2020) dissertation to evaluate the HMCT protocol. In the polygraph phase, they presented a set of Yes/No test questions three times using a digitized voice. The questions were spaced 22 seconds apart to give skin conductance, PTT, and respiration reactions sufficient time to recover before the next question was presented. The last two sessions of the HMCT followed the standard MCT protocol, which were optimal for ocular-motor measures.

Logistic regression combined features extracted from the polygraph and ocular-motor sessions to classify examinees as credible or not credible overall and on each of the relevant issues individually. On cross-validation, computer decisions were 90% correct when it classified the examinee as truthful to all relevant questions or deceptive to any one or more of the relevant questions. Decisions were 91% correct on individual relevant topics.

This research is described in greater detail in a paper listed in the reference section at the end of this document.

Hybrid DLC

In May 2021, Converus introduced the Hybrid Directed Lie Comparison (HDLC) test protocol, as well as the DLC2. The HDLC and DLC2 are similar to the standard DLC in that they are used for single-issue screening and single-issue or multi-facet diagnostic testing. The directed lie questions address minor transgressions that all examinees have committed and examinees are directed to lie to those questions during the test. For test creation, the HDLC and DLC2 are identical.

The HDLC combines traditional polygraph measures and ocular-motor measures to distinguish between truthful and deceptive people. The DLC2 uses only ocular-motor measures to distinguish between truthful and deceptive people. In short, the HDLC and the DLC2 are identical protocols with one exception: the HDLC uses data gathered by the Physio Tracker v2 during testing, whereas the DLC2 does not. Otherwise, both tests use the same test protocol. In addition to the ocular-motor signals recorded by the eye tracker, the HDLC test uses electrodermal, cardiovascular, and respiration signals as described in the HMCT section of this paper.

Converus conducted a lab study to develop and cross-validate a unique decision model for each protocol. The HDLC decision model assumes polygraph equipment is used with a standard EyeDetect Station. Mean accuracy was 89% with a range of inconclusive credibility scores between 45 and 55. The DLC2 decision model relies only on ocular-motor measures. Mean accuracy of the DLC2 was 87% with a range of inconclusive test scores between 45

and 55. With the 45-55 inconclusive region, less than 10% of HDLC and DLC2 outcomes were inconclusive. A paper that describes the research in greater detail is listed in the reference section of this document.

Comparison of Protocols

The following chart compares the various Converus test protocols.

	Use	Time	Accuracy	Topics
RCT	Screening	30 min	86%	2R
MCT **Audio MCT** **HMCT**	Screening	28 min 28 min 45 min	89% 86% 91%	3R or 4R
DLC **HDLC** **DLC2**	Diagnostic or screening	15 min 20 min 20 min	88% 89% 87%	1R, 1DL

The Algorithm

The scoring system used by EyeDetect can more appropriately be called a "Decision Model" because it consists of an algorithm and some other rules of logic. First, the algorithm is used to find a credibility score. Then, the decision model uses rules of logic to determine the final outcome or "recommendation" for that examinee.

First, a binary logistic regression equation is used to compute a credibility score. Logistic regression is a statistical method for analyzing a data set with one or more independent variables. It calculates the probability that the person was deceptive on the test as follows:

$$Pr(Deceptive) = 1 / (1 + \exp (b_0 + b_1X_1 + b_2X_2 + \ldots + b_kX_k))$$

where X_j is an ocular-motor or polygraph variable
and b_j is the optimal weight for that variable

The variables (X_j) in the logistic regression equation are based on research, and the weights for the variables (b_j) are mathematically optimal for classifying cases as truthful or deceptive. The Pr(Deceptive) is subtracted from 1.0 to get the Pr(Truthful). This probability is multiplied by 100 to get the credibility score.

If the test does not have an inconclusive region, the decision rule is to classify the person as *credible* if the credibility score is 50 or higher. If the credibility score is 49 or lower, the person is classified as *not credible*.

The Converus Credibility Score is the probability that the person was truthful multiplied by 100. A higher score means it is *more probable* that the person was truthful when they answered questions about the relevant issue. Generally, we can have greater confidence in the decision when the credibility score is close to one end of the credibility continuum than when it is near 50.

Second, after a test is scored by the algorithm, logic is applied to determine the final outcome. Most of the time, a recommendation is based solely on the credibility score; however, sometimes the rules of logic suggest other conditions were in play and the examinee should be categorized differently than just using a credibility score.

The following is a list of the different outcomes or recommendations given by EyeDetect.

1) Credible
2) Not credible: Deceptive, Confession, Probable Confession, Too Many Timeouts, Random Responses, Countermeasure
3) Indeterminate: Inconclusive, Insufficient Date from Eye Scanner, Demo Test, Aborted Test and No License

A Credible (truthful) result is based on the test score and can be interpreted to mean the examinee was credible on the test topics. In reality, it means the examinee's physiological reactions showed little or no response to the test question.

Specifically: In the RCT, MCT and Audio MCT protocols, a score between 50 and 99 is categorized as credible. For a DLC test, a score between 60 and 99 is categorized as credible. For a DLC2 or HDLC test, a score between 56 and 99 is also categorized as credible.

There are a variety of "Not Credible" outcomes. "Not Credible" indicates the decision model has categorized the examinee as deceptive, whether based on the test score alone or on the rules of logic applied.

An outcome of "Not Credible-Deceptive" indicates the examinee's score fell into the deceptive range and no other significant factors came into play. In reality, it means the examinee's physiological reactions were strong when asked about a specific topic.

An outcome of "Not Credible-Confession" indicates the test proctor recorded a confession from the examinee. No score is given due to that confession of guilt.

An outcome of "Not Credible-Probable Confession" indicates the examinee's test score was one of a few factors considered. Specifically, a probable confession occurs when an examinee appears to have confessed to participating in the target issue by answering test questions indicating guilt. Given that EyeDetect is a lie detector, it cannot ascertain deception if the examinee is not lying. Therefore, when an examinee admits to participation in the target behavior, the rules of logic indicate a probable confession.

An outcome of "Not Credible-Too Many Timeouts**"** indicates the examinee failed to respond to a statistically significant number of test questions within the designed time period. Such behavior could be intentional or an indicator the examinee was not sufficiently functionally mature to understand the questions. Again, if you are using EyeDetect Manager, you would see this happening during the test and be able to warn the examinee that they will fail unless they answer the questions more quickly.
An outcome of "Not Credible-Random Responses" indicates the examinee's test score was one of a few factors considered. Specifically, this occurs when the examinee responds randomly to a statistically significant number of test questions. This behavior could be intentional or an indicator the examinee was not sufficiently functionally mature to understand the questions.

An outcome of "Not Credible-Countermeasure" indicates the examinee's test score was one of a few factors considered. Specifically, this outcome is given in cases where the examinee's pupils dilate more than two standard deviations from the calculated mean. This is usually the case where the examinee may have used eye drops to dilate the pupils, or they have a medical condition.

An outcome of "Indeterminate-Inconclusive" indicates the test score fell within the middle of the 1 to 99 range and the rules of logic flagged the test as one that requires more investigation and scrutiny because the examinee's physiological reactions were neither strong nor weak when asked about a specific topic. This outcome only applies to DLC testing protocols.

An outcome of "Indeterminate-Insufficient Data" indicates the eye tracker was not able to measure and record a sufficient amount of testing data to appropriately score the test. Insufficient data could result when an examinee is squinting or closing the eyes when responding. It could result from challenges with the testing environment, such as too much or too little light, improper calibration, excessively dry eyes or makeup. It could result from an eye disease or condition.

An outcome of "Indeterminate-Demo Test" indicates the test was a demo test. Demo tests are available in a variety of languages. Demo tests are not intended to be scored. They take about 5 minutes and showcase the general process of an EyeDetect test. The test asks about stealing from a fictitious company and is assigned to all EyeDetect accounts.

An outcome of “Indeterminate-Aborted Test” indicates the test was ended by the test proctor, prior to completion. An incomplete test is not scored because it there is insufficient testing data to calculate a score.

There is one exception to the rules of logic. An examinee can answer questions randomly and still fail the test (outcome is deceptive) if the examinee’s physiological reactions to a test question was statistically “strong.” Deception trumps random responses and countermeasures.

Personally Identifiable Information (PII)

The information gathered by the eye tracker during a test includes:

1. Measurements of the X and Y coordinates of eye movement and pupil size. These are not photographs or biometrics and cannot be used to identify any person.
2. The examinee's answers to the test questions.

If an organization wishes to protect the identity of any examinee for purposes of reporting test results, during registration prior to taking a test, the Test Proctor can provide an identifying number rather than a person's name. The person's name may be used, but it's not required.

In addition, the Test Proctor can choose to take a photo of the person being tested. If no photo is taken, the organization will need to find test results for the tested individual based on the assigned ID number after the test is taken, saved, and scored.

EyeDetect Software

The following software programs are used to administer and score EyeDetect tests, view and analyze test results, and monitor examinees in real-time:

1) **EyeDetect Software** (computer-based) – software used for test administration; runs on a Windows-based computer provided by Converus.
2) **EyeDetect Admin** (computer-based) - software used to configure the computer to record tests and data for specific accounts (called sub-accounts).
3) **EyeDetect Manager** (computer-based) – software used by a test administrator to simultaneously monitor up to three standard EyeDetect stations while testing.
4) **EyeDetect+ Manager** (computer-based) – software used by a test administrator to monitor examinees while they are being tested with EyeDetect+.
5) **Dashboard** (web-based) – a dashboard or portal used to review test results, run reports, and manage test licenses, users, and sub-accounts.
6) **Test Manager** (web-based) – software used for test creation; it is available through the Dashboard to those who pass the certification test.

Each time an EyeDetect test is scored, the software installed on the EyeDetect station is checked to verify it is current. This ensures that the test is scored with the latest software updates. The software is always calibrated.

EyeDetect Station (Instrument)

The standard EyeDetect Station consists of a Dell laptop with stand, eye tracker, wireless mouse, chin rest and noise-cancelling headphones.

The eye tracker is a high-definition camera that attaches to the computer monitor and takes up to 60 measurements per second of the eyes. Changes as small as 1/10th of a millimeter are detected. During the test, hundreds of thousands of eye measurements are recorded, as well as the examinee's answers to the test questions.

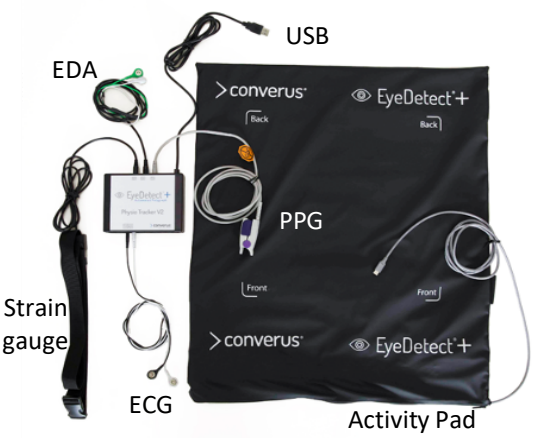
During a test, eye measurements and test responses are temporarily stored on an encrypted drive in the EyeDetect Station (laptop). When the EyeDetect Station is synchronized with a secure web server, all test and eye data are uploaded for scoring.

EyeDetect+ Equipment

EyeDetect+ tests can be administered when a standard EyeDetect Station (just described) is coupled with a Physio Tracker v2 and activity seat pad.

The Physio Tracker v2 is a multi-channel physiology monitor. When attached to an EyeDetect Station, additional sources of diagnostic information are included in the decision algorithm. The Physio Tracker v2 records the following:

- Electrodermal activity (EDA) recorded from disposable gel pads attached to two fingers on one hand
- Respiration activity recorded from a strain gauge strapped around the chest or abdomen
- Electrocardiogram (ECG) recorded from disposable gel pads attached to each wrist
- Peripheral vasomotor activity recorded from a photoelectric plethysmograph (PPG) attached to one finger
- Pulse transit time (an indirect measure of blood pressure) derived from ECG and PPG signals
- Body movement recorded from a seat activity pad with 256 sensors



Cont.

Feature Comparison of EyeDetect, EyeDetect+ and Polygraph

Characteristic	Polygraph	EyeDetect	EyeDetect+
Year introduced	1921	2014	2021
Current North American Manufacturers	Lafayette, Limestone, Stoelting, Axciton	Converus	Converus
How it works	Records changes in electrodermal, cardiovascular, and respiratory activity to measure attention and emotional arousal.	Records involuntary changes in eye movements and pupil diameter to measure cognitive effort.	Combines polygraph and ocular-motor measures. Examiner may conduct pre- and posttest interviews.
Test duration	90 or more minutes	15 to 30 minutes	20 to 45 minutes
Time to get test results and reports	Scores in 10-20 minutes; reports may take hours	Less than 5 minutes	Less than 5 minutes
Accuracy	Screening test: 85%[1] Diagnostic (investigative): 89%[1]	Screening test: 86-88%[2, 3] Diagnostic (investigative): 88%[4]	Screening test: 91%[5] Diagnostic (investigative): 89%[4]
Invasiveness	Examinee is connected to cables and sensors. Most invasive: pneumatic chest tubes and blood pressure cuff.	No sensors attached to the examinee.	Examinee is connected to cables and sensors. Most invasive: respiration strain guage.
Scoring Objectivity	Examiners interpret changes in polygraph recordings. Manual scoring of polygraph recordings requires training and may introduce a potential source of error.	Automated testing process and scoring.	Automated testing process and scoring.
Training	Ten weeks of training, ongoing evaluation, and continuing education courses.	Standard training is 4 hours; advanced training is 2 additional days.	Standard training is 5 hours; advanced training is 3 additional days.
Big takeaway	Has been the de facto lie detector since 1921.	First ocular-motor deception test	First automated polygraph

1. Source: Meta-Analytic Survey of Criterion Accuracy of Validated Polygraph Techniques, 2011 | 2. Source: Laboratory and Field Research on the Ocular-motor Deception Test – European Polygraph Journal, Vol. 10, 2017, No. 4 (38) | 3. Source: Ocular-Motor Methods for Detecting Deception in a Multiple-Issue Screening Protocol – A. Potts Doctoral Dissertation, August 2020 | 4. Source: EyeDetect Hybrid Directed-lie Comparison Test (HDLC) Development and Validation Study, May 2021 | 5. EyeDetect Hybrid Multi-Issue Comparison Test (HMCT) Development and Validation, May 2021.

Security

In terms of system security, EyeDetect Station v3 and v4 include a secure internal disk enabled by Microsoft BitLocker that is 256-bit AES encrypted. All test data are encrypted and can be accessed only by users that enter the key or password to unlock the drive. Test data are encrypted using a unique key per customer before being transferred to our secure data center. Once the data are transferred to the data center, they are deleted from the BitLocker drive.

The Converus Dashboard web application is accessible using two-factor authentication. All access to the dashboard is done through SSL. Only authorized users of an account with applicable rights can access the dashboard. Converus uses standalone (non-hosted) servers owned by Converus, not the data center, to store and process user data collected during testing. Access to these servers is controlled by a firewall and incoming web traffic is monitored for threats. All servers are housed in a private, locked rack in an SSAE 16/ISAE 3402 certified data center. Access to the data center floor is controlled by key card and biometric scanners and is monitored 24/7.

Countermeasures

Deceptive examinees may attempt to cheat to avoid detection. Additionally, truthful examinees may attempt to influence the test outcome to show they are truthful. Preliminary validation studies indicate these efforts do impact testing outcomes. Even highly motivated subjects cannot simultaneously control their reading behaviors, response speed, response accuracy, or pupil dilation. Examinees have insufficient time to attempt physical or mental countermeasures.

Some examinees may use eye drops or medications to artificially dilate the pupils. This type of activity is detected during testing. The software checks for pupil diltations more than two standard deviations from the calculated mean. When this happens, the test can be postponed until the effects of the drugs or medications have worn off.

Some examinees may attempt to cheat by closing their eyes or squinting. The test proctor easily detects this behaior using EyeDetect Manager or EyeDetect+ Manager or when the computer reports significant data loss.

Some examinees may attempt to cheat by answering all questions randomly or by answering all questions with the same response (either all true responses or all false responses). These countermeasures are also detected, and the examinee will be classified Not Credible.

Training and Certification

The administration and use of EyeDetect requires basic training. An automated decision model (with algorithm) evaluate test responses and eye behaviors to derive a test score. For information on training and certification, visit https://converus.com/training/. The two primary types of roles and training are as follows:

1) **Test Proctor or Test Proctor+ training** – This course is for those who wish to wish to administer EyeDetect tests on examinees using a standard EyeDetect Station or an EyeDetect+ Station (standard station + physio tracker).

2) **Dashboard Administrator training** – This course is for those who wish to manage test results, test reports, user access, test licenses, and sub-accounts.

Advanced courses include:

1) **MCT Test Writer** – This course is for those who wish to write screening tests. The class focuses on the MCT protocol and makes refernce to the RCT protocol. Practical exercises are required to show competence.

2) **Audio MCT Test Writer** – This course is for those who wish to write Audio MCT tests. It is an incremental course describing the differences between standard MCT and AMCT tests. Practical exercises are required to show competence.

3) **Hybrid MCT Test Writer** – This course is for those who wish to write hybrid MCT Test Writers. It is an incremental course describing the the differences between the standard MCT and HMCT tests. Practical exercises are required to show competence.

4) **Hybrid DLC or DLC2 Test Writer** – This course is for those who wish to write directed lie tests, often use in diagnostic testing. The class focuses on the Hybrid DLC/DLC2 protocol. Practical exercises are required to show competence.

5) **Investigative interviewer** – This course is for those who wish to learn or enhance their interviewing skills for pre-test or post-test interviews. As part of this course, the PEACE model is taught. In this training, participants are taught to assist the the examinee in creating a free narrative of the events in question, without interruption, before challenging inconsistencies or contradictions.

6) **Tech Support Specialist** - This course is for those who wish to resolve an occassional hardware or software issues related to EyeDetect, Microsoft Windows, wireless networks, digital voices, and more. The course is technical in nature.

Test Topics

EyeDetect test templates are written by a trained team using time-tested protocols and techniques based on polygraph testing best practices. Customers may be trained to modify the test tempates to meet specific requirements. In the U.S., lie detection tests are generally limited to federal, state, or municipal government employees. In other countries, tests can be administered to employees of private companies.

The following is a list of potential test topics. Up to four topics can be combined in a multiple-issue test, or diagnostic tests can be designed to test a single issue.

- Theft
- Drug use
- Divulging confidential information
- Ties to gangs or organized crime
- Bribery
- Document fraud
- Drug trafficking
- Other fraud (financial)
- Kidnapping
- Money laundering
- Sex-based crimes
- Corporate espionage
- Fuel theft
- Counterfeiting money
- Cyber crimes
- Identity theft
- Terrorism
- Document fraud
- Violent crimes
- Sexual abuse
- Athlete doping
- Unauthorized financial transactions
- Use of date rape drugs
- Parole violations
- Theft of car parts
- Sports event fixing

LEPET

The EyeDetect law enforcement pre-employment test (LEPET) format is used to screen public safety job applicants or lateral transfers for various disqualifying behaviors, such as drug use, undisclosed criminal history, or falsification of the job application.

PCSOT

In the United States, post-conviction sex offender tests (PCSOT) are widely used to test convicted sex offenders now on parole or persons on restrictions or probation. There are EyeDetect templates for the following use cases:

- Instant offense (first offense) – Did you commit the crime?
- Monitoring – Have you committed the crime again?
- Maintenance – Have you violated the conditions of treatment, probation, or parole?
- Sex History – Did you previously disclose all of your sexually -related past aspects of concern?

For each PCSOT test, there are EyeDetect templates written for the following offenders:

- Adult sex offender with an adult victim
- Adult sex offender with a child victim
- Adult sex offender – child pornography
- Adult sex offender – voyeur or exhibitionist
- Juvenile sex offender

Specific Test Types

As a more specific example of testing options, consider the following list of test topics that could be used by a financial institution, bank, or insurance company to evaluate current employees based on job description or function. In addition, tests can be written to include the organization name and other familiar information.

1) Falsification of credit applications
2) Unauthorized financial transactions
3) Falsification of insurance claim forms
4) Falsification of company checks
5) Stealing company checks
6) Stealing cash from the bank or from customers
7) Converting company assets to cash illegally
8) Asking for or receiving bribes from contractors or suppliers
9) Providing information or receiving payments from cartels or organized crime
10) Divulging confidential information to unauthorized persons

Vertical Market Use Cases

As a credibility assessment tool, EyeDetect is intended to help organizations screen job applicants, current employees, law enforcement, or security personnel. It can be used to reduce corruption, fraud, theft, and other inappropriate or illegal behaviors. The following are a few organizational use cases:

- Military school admissions
- Law enforcement pre-employment
- National security ongoing eval
- Drug enforcement ongoing eval
- Border patrol pre-employment
- Customs pre-employment
- Postal service routine evaluation
- Casino personnel pre-employment
- Armored car pre-employment
- Security guard pre-employment
- Petroleum ongoing eval
- Mining
- Shipping/logistics
- Insurance/banking
- Retail
- Manufacturing
- Hospitality
- Medical/dental

Today's Credibility Assessment Methods

Organizations worldwide use various deception detection tools when assessing the credibility of job applicants, employees, and others.

Intuition - the Unassisted Human Lie Catcher Hypothesis

By far, the most frequently used lie detector is human intuition. In other words, many organizations rely on face-to-face interviews to assess the truthfulness of a job applicant or employee. Unfortunately, behaviors such as gaze aversion, touching the body or face, or covering the eyes or mouth while speaking have not been found to be reliable indicators of deception. Despite popular belief, there are no reliable nonverbal deception cues.

Liars, concerned about being believed, often come across as helpful and truthful in an interview and try to impress the interviewer. Truthful individuals, under stress, often demonstrate many of the stereotypical behaviors associated with deception: speech errors, fidgeting, and gaze aversion.

A 2006 effort to summarize over 200 peer-reviewed studies demonstrated that humans have an accuracy rate of 54% at predicting deception.[9] This estimate included accuracy rates from skilled examiners trained in state-of-the-art observational and interrogation techniques. In short, as credibility assessment tools, humans are about as accurate as the flip of a coin.

[9] Bond & DePaulo, 2006

Integrity Tests

Integrity tests are also frequently used by HR departments as a method of screening. Sadly, studies show that these types of tests are not accurate at determining deception. In a study entitled, "The Criterion-Related Validity of Integrity Tests: An Updated Meta-Analysis" in the Journal of Applied Psychology (2012), researchers reviewed 104 studies of integrity tests. Overall mean observed validity estimates and validity estimates corrected for unreliability in the criterion (respectively) were as follows:

- Job performance = .12 and .15
- Training performance = .13 and .16
- Counterproductive work behavior = .26 and .32
- Employee turnover = .07 and .09

With respect to the ability of integrity tests to predict behaviors:

- Counterproductive work behavior such as substance abuse, theft, and withdrawal
  - Results were moderately accurate from self-reports
  - Results were poor from employee records
- Job performance, training performance, and turnover were poor
- Job performance was poorer for non-published studies (.12) than published studies (.27)

To summarize, integrity tests have a low predictive value for employee behavior for the following reasons:

- Self-reporting and attitude tests are easily faked
- Tests do not directly assess many disqualifying factors, e.g., criminal relationships, drug abuse, terrorism, criminal activity, financial problems, etc.

Computer Voice Stress Analyzer

Computer voice stress analyzer technology was developed to record psychophysiological stress responses that occur to the muscles in the voice box when under duress, such as a lie detection test. The tightening or loosening of the voice box changes the sound of the voice.

One study on computer voice stress analysis showed that true positive rates (i.e., predicting deception) ranged from 50% to 65%, and the false positive rate was often higher.[10]

Other studies that have drawn similar conclusions include:

- Journal of Forensic Sciences, 53(1), 183-193, Hollien and Harnsberger (2008).
- The Journal of the Acoustical Society of America 124(4):2458, October 2008, Hollien and Harnsberger, "Evaluation of two voice stress analyzers," J. Acoust. Soc. Am. 124(4):2458, October 2008.
- Journal of Forensic Sciences 54(3), 2009, Harnsberger, Hollien, Martin, and K Hollien, "Stress and Deception in Speech: Evaluating Layered Voice Analysis."
- National Research Council, Robert Pool, Field Evaluation in the Intelligence and Counterintelligence Context, 2009.
- Journal of Forensic Sciences, Hollien et al., "Evaluation of the NITV CVSA," 2008.

Electroencephalogram and fMRI (brain scanning)

The electroencephalogram has been shown to identify deceptive individuals with the following protocol:

- Subject views familiar stimuli, which creates a positive baseline (subject sees a friend).
- Subject views unfamiliar stimuli, which creates a negative baseline (subject sees a stranger).
- Person is probed on topics on which truthfulness is tested.

Several research papers were published on the electroencephalogram that claimed to have achieved 87% accuracy

[10] Journal of Forensic Sciences, 53(1), 183-193, Hollien and Harnsberger (2008).

(i.e., they could accurately predict if a person was lying 87% of the time) using electrical activity at the surface of the scalp. The challenge with this technology is that it is very costly and invasive.

The fMRI can create real-time 3-dimensional models of the brain using powerful magnets to charge hydrogen protons within cells. A radio frequency is broadcast by these protons, which absorb the frequency and reflect it back at a receiver. These data are converted into an image. Essentially, the fMRI measures increases in blood flow to particular regions of the brain. It measures what is called the blood oxygen level-dependent (BOLD) signal. Large patterns of activity are generated in initial brain scans, and irrelevant signals are filtered out. An interior structure and function map are generated to associate external stimulus to changes in localized blood flow.

Although it can be highly accurate, the fMRI is costly. Testing works best when analyzing a pool of subjects, not individuals. There is no industry standard, and it is not known if countermeasures can be used to defeat the test.

Polygraph

The polygraph has been the worldwide standard in lie detection for many decades. The American Polygraph Association (APA) published a study[11] in 2012 that reported, excluding outlier results, comparison question techniques intended for event-specific (single issue) diagnostic testing, in which the criterion variance of multiple relevant questions is assumed to be nonindependent, produced an aggregated decision accuracy rate of .89, with a combined inconclusive rate of .11.

Comparison question PDD techniques designed to be interpreted with the assumption of independence of the criterion variance of multiple relevant questions, produced an aggregated decision accuracy rate of .85 with a combined inconclusive rate of .13.

Another study by Krapohl in 2002[12] revealed similar findings. Thus, the polygraph remains an accurate method of deception detection when used for event-specific questioning. However, for pre-screening employees or conducting general periodic testing, polygraph tests are less accurate.

The polygraph may be less accurate for screening than specific-incident testing because the issues are far more general. The generality of relevant questions in screening polygraph examinations is desirable from the point of view of the hiring agency because these questions cover a wide range of potentially undesirable behaviors of concern. However, the generality of relevant questions may introduce ambiguity in the mind of the examinee about their guilt ("I haven't used illegal drugs in the past 90 days, but I did 6 months ago, and I that was wrong.").

In screening contexts, the same set of test questions may be used repeatedly for different examinees. Standardization of test protocols lessens concerns about variance in outcomes due to question formulation. However, the validity of a polygraph screening test that includes probable lie questions is likely to be compromised not only by variance in the skills of examiners, but also the extent to which the relevant questions are broad enough in scope to meet the needs of the testing organization.[13]

Suitability for EyeDetect Testing

The following are basic guidelines to indicate the characteristics of suitable examinees who take standard EyeDetect tests:

1) As with other psychophysiological tests, examinees should be well-rested and nourished before the test.

[11] Meta-Analytic Survey of Criterion Accuracy of Validated Polygraph Techniques, 2012, table 2.
[12] Krapohl, D. J. (2002). The polygraph in personnel screening. In M. Kleiner (Ed.) Handbook of Polygraph Testing. 217-236. San Diego: Academic Press.
[13] Meijer, Verschuere, Merckelbach, & Crombez, 2008

2) Functional maturity as it relates to comprehension skills are more important than age. Examinees must be able to comprehend standard test questions. Examinees with reasonable reading skills as young as 11 years old have been successfully tested.
3) Examinees must see well enough to read a computer monitor unassisted or with single magnification glasses, including readers. We also recommend that progressive lenses be avoided, if possible, to reduce the risk of misreading the pupil.
4) Examinees impaired by alcohol or drugs should be asked to return at a later date for testing.
5) Examinees that have used eye drops such as tropicamide, an antimuscarinic drug that produces short-acting pupil dilation, should be asked to return at a later date for testing.
6) Examinees with excessively dry eyes related to the use of antihistamines, age, or other eye conditions may be difficult to test due to calibration issues with the eye tracker. However, lubricating eye drops resolve the issue sufficiently for testing. As long as the EyeDetect software can calibrate the eye tracker, testing may proceed.
7) Examinees wearing excessive mascara, eyeliner, or false eyelashes may be difficult to calibrate with the eye tracker. Removal of the make-up usually resolves the issue.
8) A standard EyeDetect test does not measure heart rate, respiration, blood pressure, or skin conductance, and conditions that affect those physiological measures do not impact EyeDetect test results.

The examiner may administer two diagnostic tests if there is reason to believe the examinee has used eye drops or medications to alter the pupil response or has had a traumatic brain injury:

- Pupillary Light Reflex Diagnostic test: Used to assess brain stem function. Abnormal reactions suggest optic nerve injury, oculomotor nerve damage, brain stem lesions, tumors, or the use of medications like barbiturates.
- Digit Span Diagnostic test: Used to measure working memory, mental manipulation, rote memory, and learning, attention, and encoding.

The following conditions should not negatively impact examinee suitability unless it significantly impacts their mental acuity or physical functionality:

1) Attention Deficit Disorder (ADD)
2) Post-traumatic Stress Disorder (PTSD)
3) High functioning autism or Asperger's Syndrome
4) Mild atrial or ventricular arrhythmia or premature ventricular contraction (PVC)
5) Asthma or other breathing disorder
6) Hyperhidrosis (excessive sweating)
7) Mild anxiety
8) Pregnancy
9) Use of common medications such as antidepressants
10) Children as young as 11 years old have been successfully tested

Suitability for EyeDetect+ Testing

Converus recommends following the suitability recommendations published by the American Polygraph Association (APA) found in the article "Model Policy for the Evaluation of Examinee Suitability for Polygraph Testing."

Research

The Converus Science Team, led by Dr. John Kircher, has published 19 articles or reports about the technology underlying EyeDetect® or EyeDetect+®. In the published research, EyeDetect is referred to as an ocular-motor deception test (ODT). There are 11 peer-reviewed research articles on EyeDetect.

Obtaining peer-reviewed research takes much effort and time. When research is published in peer-reviewed articles, the research methods are scrutinized by independent scientists who do not have a financial interest in the research. EyeDetect has more peer-reviewed research than any specific polygraph technique.

Dr. Kircher has conducted scientific research and development on deception detection and polygraph techniques since the 1970's. He co-developed the computerize polygraph in the early 1990's with Dr. David Raskin and created a scoring algorithm for that polygraph implementation.

Note: Sources 1-11 are peer-reviewed.

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