



## **Automated Deception Detection for Adult and Juvenile Offenders**



March 2019

Copyright © 2019 Converus, Inc. All Rights Reserved. Converus and EyeDetect and the Converus and EyeDetect logos are registered trademarks of Converus, Inc. in the United States and/or other countries. Microsoft and Windows are either registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

**Converus, Inc.**

610 S. 850 E., Suite 4

Lehi, UT 84043 USA

+1-801-331-8840

[www.converus.com](http://www.converus.com)

## Introduction

Studies show that deception takes more mental effort than telling the truth.<sup>1</sup> Deceptive individuals use more mental resources to fabricate lies, remember the specifics of their lies, and portray to others that their lies are believable. Deceptive individuals also try to control their emotions; they do not want to “leak” any facts or information that could cause their deception to be discovered<sup>2</sup>.

Scientists refer to this mental effort as cognitive load. This document discusses how cognitive load and its correlation to certain eye behaviors can be measured and analyzed to indicate deception. This is a revolutionary discovery that is not only improving the science of deception detection but also changing the way credibility assessment professionals conduct their business.

## The Scientific Discovery

In early 2002, University of Utah researchers Drs. John Kircher and Doug Hacker met with Don Krapohl. At the time, Don was a credibility assessment researcher and polygraph program director for the U.S. Central Intelligence Agency and eventually became the Deputy Director of the U.S. National Center for Credibility Assessment (NCCA).

Dr. Kircher is one of the world’s leading experts in credibility assessment. He has published more than 50 scientific articles on the topic and consulted with the National Science Foundation, the CIA, the U.S. Secret Service, the National Institute of Justice, the U.S. Department of Homeland Security, the National Science Foundation, the National Research Council, the Royal Canadian Mounted Police, and many other organizations.

In the meeting with Don, Dr. Hacker mentioned the adage, “The eyes are the windows to the soul.” Dr. Kircher suggested that it would be interesting to conduct basic research to determine if there were measurable markers in the eyes during deception. He proposed a research concept to the CIA and they gave him a grant to buy the latest eye-tracking hardware to conduct a study (shown below).

Applied Sciences Laboratory



Arrington Research



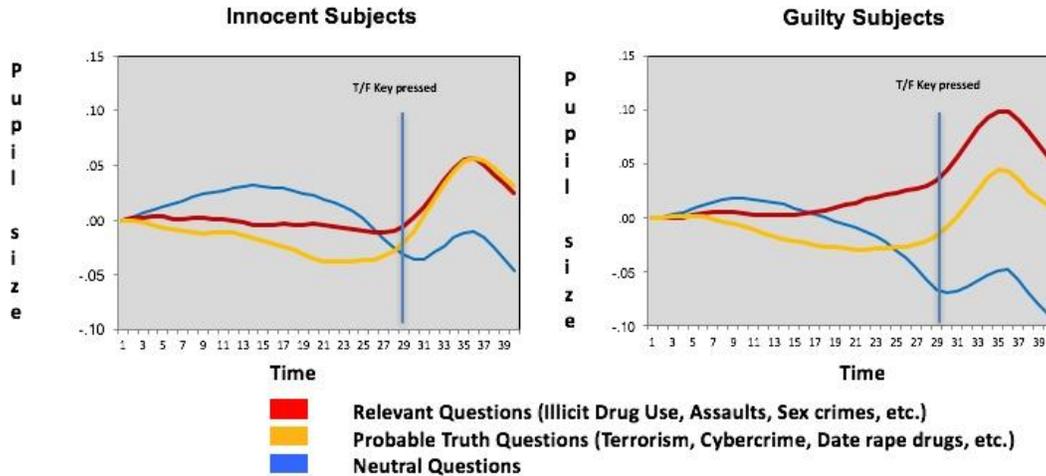
The University of Utah researchers began with lab experiments on campus using a “mock crime.” One-hundred study participants were instructed to steal \$20 from a department secretary’s purse when she turned her back. Another 100 participants were tested as part of a control group and did not steal any money. The scientists offered a \$20 bonus to participants involved in the theft of \$20 if they could pass the ocular-motor deception test appearing as “innocent.” The data for these tests was gathered by eye tracker.

---

<sup>1</sup> Johnson, Barnhardt, & Zhu, 2005; Kircher, 1981; Vrij, Fisher, Mann, & Leal, 2000.

<sup>2</sup> Kircher, 1981

In the studies, the guilty participants showed a relative increase in pupil dilation when answering questions about the theft. The innocent participants did not show marked changes. Dilation of approximately 1/10th of a millimeter occurred in the guilty subjects and it persisted for 3-4 seconds afterwards. (See below.)



The image on the left labelled “Innocent Subjects” shows the pupil dilation pattern of truthful people. The red line (relevant questions) and yellow line (probable truth questions) are similar, which means their eyes did not dilate differently on the relevant question (i.e., Did you steal the money?)

The image on the right, labelled “Guilty Subjects,” shows the pupil dilation pattern of deceptive subjects. The red line indicates more dilation for relevant questions than probable truth questions. This gap between the yellow line and red line is measured and analyzed by a computer algorithm and a “credibility score” is given.

Kircher and Hacker realized these results were a scientific breakthrough and asked other scientists to assist with the research. Drs. David Raskin, Dan Woltz and Ann Cooke soon joined the research team. Since that time, this core group of five scientists have worked to improve the computer algorithm as they have conducted additional lab and field studies.

### Scientific Validation

Pupil dilation is a leading indicator of deception. But other eye behaviors are also diagnostic. Deceptive individuals blink less often, respond faster and make fewer eye fixations. In 2012, the peer-reviewed article “Lying Eyes: Ocular-motor Measures of Reading Reveal Deception”<sup>3</sup> was published in the *Journal of Experimental Psychology: Applied* with the initial findings of the science team. Since that time, the team has conducted additional research to determine if the same eye behaviors are consistent among test subjects in other languages and cultures. Lab and field studies have been conducted in Latin America and the Middle East.



In 2016, Kircher conducted field studies with the support and assistance of three groups in the Mexican federal government and published new data that showed the mean accuracy of ODT to be 86% for screening tests using the Relevant-Comparison Test (RCT) protocol. The data was published in

<sup>3</sup> “Lying Eyes: Ocular-motor Measure of Reading Reveal Deception,” *Journal of Experimental Psychology: Applied*, 18(3), 301-313, 2012.

December 2016 in “Laboratory and Field Research on the Ocular-motor Deception Test” in the European Polygraph Journal.

In 2018, Kircher and Raskin reviewed field data on a small sample of tests using the Directed Lie protocol, which is primarily used for diagnostic or single-issue testing. That data showed the mean accuracy of that protocol to be over 90%. More data will be gathered prior to any publication.

EyeDetect tests are consistent due to the standardization and automation. EyeDetect eliminates many potential “human factors” such as bias, temperament, and competence, which can decrease the accuracy of human administered credibility assessment tests.

### **Converus**

After the published the peer-reviewed study in 2012, a group of interested parties contacted the Technology Transfer Office at the University of Utah. The role of the Technology Transfer Office is to help professors sell or license their inventions or discoveries to investors that want to commercialize the scientific breakthroughs.

Alta Ventures, a venture capital fund in Salt Lake City, Utah, formed a company to bring this technology to market. The company, now called Converus, acquired the rights to ODT from the University of Utah and signed agreements with the scientists to continue their research and development.

Alta Ventures also hired an experienced executive team for Converus to commercialize the science. After years of product development, ODT science was released as EyeDetect® in 2014. Converus investors now include three venture capital funds, company executives, scientists, and other well-known technology investors. Converus is the first venture-backed technology supplier to deliver new tools to the credibility assessment market.

### **EyeDetect Hardware**

EyeDetect is a hardware and software solution. The hardware is an Intel NUC mini-PC with Microsoft Windows 10. A high-definition, infrared eye-tracking camera is mounted on the bottom of the monitor and takes 60 measurements per second of each eye with measurements as small as 1/100 of a millimeter.



### **EyeDetect Software**

The software for administering tests, monitoring examinees, scoring and viewing test results includes:

- 1) **EyeDetect Software** – allows tests to be downloaded from the cloud to be administered on the tablet and it uploads test data to a cloud-based server.
- 2) **EyeDetect Manager** – allow the test proctor to observe examinees remotely. It runs on any Windows computer that is on the same Wi-Fi network with the tablet.
- 3) **EyeDetect Dashboard** - a web portal providing access to test results and individual test reports that reside on cloud-based servers. Test reports can be viewed from any web browser.
- 4) **EyeDetect Administrator** – allows one tablet to be configured for a variety of organizations or agencies, to keep test results separated and confidential.

Tests are created by Converus and are downloaded via the Internet onto the tablet. Examinees read true/false statements onscreen and respond to True/False questions by pressing mouse buttons (left/green is true and right/red is false).



Currently, there are over 2,000 unique tests in 30 different languages in the Converus test library. Tests are localized for different countries to ensure that test topics are well understood and local language is used. For example, tests in Spanish have been localized for Mexico, Colombia, Panama, El Salvador, Guatemala, Peru and the Dominican Republic.

Tests cover a wide variety of topics, including sexual assault, sexual abuse, domestic violence, parole or probation violations, therapy program violations and other issues. Tests are completed in 15 to 30 minutes. EyeDetect tests begin with an automated pre-test explanation of topics using an audio-visual presentation on the screen. Afterwards, two short practice sessions are given to familiarize the examinee with the testing process. Finally, the test is administered.

The examinee responds to approximately 300 questions per test. If an examinee doesn't answer quickly enough, the statement will "time out." This is part of the science, as it is more difficult to lie under rapid questioning. Once the test is completed, the eye tracker and other data is uploaded to a secure web server and a Converus Credibility Score is calculated in less than 5 minutes.

Test reports are available in PDF or HTML format, and a "Guidance Category" is given for each examinee. The most common guidance categories are "Credible" (Truthful) and "Not Credible" (Deceptive). There are no inconclusive EyeDetect tests. The software includes a pop-up window to record confessions and admissions at the end of the test.

### **Testing Process**

EyeDetect tests can easily be administered in-office in 15 to 30 minutes. Results are available in less than 5 minutes after the test concludes.

Tests are created by Converus and are downloaded via the Internet onto the tablet. Examinees read true/false statements onscreen and respond to True/False questions by pressing mouse buttons (left/green is true and right/red is false).



The examinee responds to over 300 statements per test. If an examinee doesn't answer quickly enough, the statement will "time out." This is part of the science; it is more difficult to lie when responding quickly. Once the test is completed, the eye tracker data is uploaded to a secure web server and a Converus Credibility Score (between 1 and 99) is calculated within 5 minutes.

Test reports are available in PDF or HTML format, and a "Guidance Category" is given for each examinee. The most common guidance categories are "Credible" (Truthful) and "Not Credible" (Deceptive).

Sex offenders should be encouraged to show integrity and disclose information that might better explain their Converus credibility score, especially if a low (deceptive) score is given. Any admissions or confessions could be written, notarized, scanned and attached to an offender's electronic record.

## Countermeasures

Countermeasures are actions taken by examinees or suspects to counteract testing procedures. There are Web sites and YouTube videos that teach people how to defeat credibility assessment tests. To identify and interrupt countermeasures, Converus has supplied EyeDetect and contracted with Dr. Charles Honts, a researcher at Boise State University. Dr. Honts is a leading expert on countermeasures, and with his help Converus has developed the following countermeasure detection tools:

- 1) To determine if an examinee is using drugs or eye dilation drops, EyeDetect administers a 45-second "light test" to ensure that the examinees' pupils are reacting normally when the screen goes from light to dark. The pupils should dilate normally when light is removed.
- 2) Examinees may close their eyes or squint when responding to questions. This is easy to detect because EyeDetect software tracks data loss, which directly corresponds to these conditions.
- 3) Some examinees answer all questions the same way (true or false), fail to answer questions, or answer randomly to avoid thinking about responses. EyeDetect alerts the test proctor when an examinee is using these countermeasures and delivers guidance categories such as: (a) Indeterminate, (b) Insufficient Data from Eye Scanner, (c) Not Credible/Too Many Timeouts or (d) Not Credible/Random Responses or Low Comprehension.

Also, Dr. Honts stated:

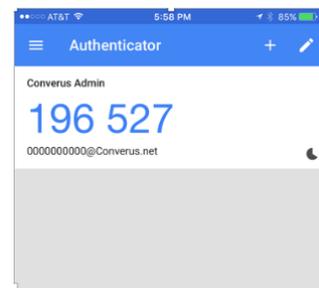
"The countermeasures that are used to beat other credibility assessment tools invoke autonomic responses over a relatively long period. Simply put, tests can be beaten because the examinee has enough time for the countermeasures to work. EyeDetect test questions are delivered rapid fire (every 3-4 seconds), so examinees must pay close attention and stay mentally involved to answer the questions correctly. Also, the response mechanisms in the pupil are faster than the systems measured by other credibility assessment tools. The rapid response of the pupil makes it very difficult to mask a deceptive response to a question.

Countermeasure designed to produce responses to control questions would take longer to evoke pupillary changes than the innate response to questions being answered deceptively. Moreover, the rapid questioning in an EyeDetect examination would make it extremely difficult for an examinee to attempt a countermeasure designed to produce a pupillary response and still maintain accurate responses in the test. For these reasons, I do not currently see any immediate active countermeasure threats to EyeDetect."<sup>4</sup>

## Security

The EyeDetect tablet uses Microsoft BitLocker to encrypt test responses and eye measurements stored temporarily on the tablet. Once the test data is synchronized with the Converus data center, it is deleted from the BitLocker drive.

Access to test reports online requires a two-step (two-level encryption) login process from any web browser. After a person provides their user name and password, a unique 6-digit number is required. This unique number is created by a mobile app such as Google Authenticator on a smartphone (right). Only authorized users can access the test results on



<sup>4</sup> Email correspondence between Dr. Honts and Converus on January 12, 2017.

the Converus dashboard.

Converus web servers store and process eye measurements and test responses 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 a certified data center. Access to the data center is controlled by key card and biometric scanners and is monitored 24/7.

Some EyeDetect customers may not want personal information uploaded to Converus' web servers. In those cases, you may assign a unique number to each examinee to remove all personally identifiable information. Only the test responses and eye measurements would be uploaded.

## Training

With EyeDetect, the computer is the test administrator and examiner. Extensive training is not required to administer a test. Converus offers the following two, free training courses on YouTube. Also upon successful completion of a test, a certification is awarded.

1. **Test Proctor training – (45 minutes)** Instructs how to set up the EyeDetect Station, calibrate the eye tracker, start a test, and upload test data. Also includes how to setup and use EyeDetect Manager for monitoring examinees. If desired, there is a Test Proctor certification exam.
2. **Dashboard Administrator training – (45 minutes)** Instruction on how to access test results from the Dashboard. Administrators also learn how to add users and manage test licenses.

## Sex Offender Tests

Treatment providers, supervising officers (pardons/parole), and polygraph examiners work together to manage and treat sex offenders convicted of sexual assault, sexual abuse, exhibitionism, voyeurism and viewing child pornography, among other crimes. EyeDetect tests are available for specific issues, re-offense, probation/parole violations and sex histories.

EyeDetect is also nonintrusive as there are no wires or sensors attached to the examinee. Such things have shown to be uncomfortable for those with mental disorders such as Post-Traumatic Stress Disorder (PTSD) or Attention Deficit Disorder (ADD) or for others with character disorders such as Autism spectrum disorder (ASD) or Asperger syndrome (AS).

In the past, polygraph test construction and proper questioning for such sex offenders has been done improperly. According to expert polygraph examiners, at least 70% of sex-offender polygraphs performed in the United States are improperly administered and scored.<sup>5</sup>

In states where treatment providers contract with government agencies, these providers subcontract for and direct the services of a polygraph examiner. In other states, supervising officers contract with and direct the polygraphist.

Treatment providers and supervising officers are not experts in lie detection and their natural inclination is to instruct examiners to ask broad and open-ended questions. These types of questions do not adhere

---

<sup>5</sup> The use of Clinical Polygraph in the Assessment and Treatment of Sex Offenders, 5<sup>th</sup> Annual CSOT Conference, San Marcos, TX. Sunday, February 19, 2017.

to the [American Polygraph Association \(APA\) Post-Conviction Sex Offender Testing policies](#), which were released in 2009. As such, polygraph examiners may be reluctant to correct those paying their service fees, so rather than insist on proper test question construction, they routinely use inappropriate questions.

Also, there is wide variability in polygraph examiner training, temperament, competence and bias. Examiners can look at the same physiological charts and have different opinions on whether deception is indicated.

EyeDetect was created by polygraph experts to minimize the subjectivity inherent with human examiners in obtaining an accurate assessment of an offender's credibility. Sex offender test questions are properly constructed and cannot be altered on-the-fly by an examiner, treatment provider, or supervising officer.

Offenders report feeling that EyeDetect is more "fair" because it is standardized and computerized. Also, EyeDetect does not require the switching of examiners due to habituation to a specific examiner. For these reasons, compliance rates are likely to increase.

### Juvenile Sex Offenders

On February 7, 2017, Mike Miner, President of the Association for the Treatment of Sexual Abusers (ATSA), issued the following Adolescent Guidelines Statement: "... without a clearly identified benefit and with a potential for harm, ATSA recommends against using polygraph or plethysmography with adolescents under age 18."



Adolescents are very comfortable with mobile devices, tablets and computer screens. A survey<sup>6</sup> conducted by Common Sense Media found children between the ages 8 to 12 years spent six hours with digital media and teens averaged nine hours daily. This included web browsing, social media, streaming music and videos, texting, TV, and gaming. School or homework-related screen time was not included in this data. Also, 35 percent of U.S. children first play with a mobile device before age 2 and almost 85 percent of teens have smartphones. Thirty-four percent admit using their phones almost constantly. In short, juvenile offenders are often more comfortable in front of a computer than in front of another person.



For this reason, EyeDetect is a promising screening tool for juvenile offender sex histories and maintenance. Converus has already designed EyeDetect tests for juveniles and is actively working with ATSA chapters to conduct field studies. Converus will provide this study data to the national ATSA board and local ATSA chapters.

Cont.

---

<sup>6</sup> Common Sense Media, San Francisco non-profit, 2015 survey of 2,600 children ages 8 to 18.

Below is an example of instructions and real questions that are being used for juvenile maintenance:

### **Test #65301 - Juvenile sex offender probation violations**

#### Pre-test instructions

This is a lie detection test to find out if you have used any date rape drugs. The test will also ask if you have violated any of the conditions of your probation.

First, probation officials are aware and concerned that some sex offenders have given date rape drugs to other people to make it easier to have sexual contact with them, or to assault them. Date rape drugs include Rohypnol, GHB and ketamine, as well as tranquilizers such as Xanax, Valium and Klonopin. Any involvement with these types of drugs to commit a sex crime will result in an investigation by the police. As a sex offender, if you use a date rape drug to have sexual contact or to sexually assault someone, it is a serious crime and you may be arrested, prosecuted, and sent to jail.

Second, we are concerned that you may have violated conditions of your probation. Probation violations could include: 1) using illegal drugs, synthetic drugs, or alcohol; 2) cheating on a urinalysis test; 3) having contact with people that are forbidden or restricted; or 4) sneaking away from supervision. There may be other conditions not mentioned here that you have been ordered to do as part of your probation. It is also a probation violation to commit new crimes, even if you have not been caught. In this lie detection test, you will be asked about using date rape drugs and you will be asked if you are guilty of any probation violations.

Think about your activities. Have you given someone date rape drugs to have sex? Have you used any illegal drugs or synthetic drugs? Have you had any alcohol? Have you misused any prescription drugs? Have you cheated on a drug urine test by taking something or by using a device? Have you worked with or hung out with any criminal gang members? Have you spoken to or hung out with anyone on your "no contact" list? Have you hung out with anyone on probation, on parole, or other type of supervision? Have you snuck out of your house? Have you snuck away from supervision? While under supervision, have you left your home past curfew or skipped school? Have you violated any other conditions of your probation and hid it from your probation officer?

In summary, this test will ask you about using date rape drugs. As previously mentioned, you will also be asked about violating the conditions of your probation. Some examples could include: 1) using illegal drugs, synthetic drugs, or alcohol, 2) cheating on a drug urine test, 3) having contact with people that are forbidden or restricted, or 4) sneaking away from supervision. If you are guilty of using date rape drugs or if you have violated probation, please tell the test administrator now.

The following are examples of relevant questions asked during an EyeDetect test:

1. I have not committed any probation violations.
2. I have been truthful with my probation officer about my behavior.
3. I have lied to my probation officer about my behavior.
4. I am guilty of a probation violation.

The following are examples of probable truth (comparison) questions asked during an EyeDetect test:

1. I have never used a date rape drug on someone to have sex.
2. I am guilty of using date rape drugs to have sex with someone.
3. I used a date rape drug to have sex in the past.

## Suitability for EyeDetect Testing

The following are basic guidelines to indicate the characteristics of suitable examinees.

- 1) As with any other psychophysiological test, examinees should get a good night's rest and have a meal prior to testing.
- 2) Functional maturity as it relates to reading and comprehension skills are considered more important than age. Examinees must be able to read and comprehend standard test questions. Note: Examinees with reasonable reading skills as young as 11 years old have been successfully tested.
- 3) Examinees must be able to see well enough to read a computer monitor unassisted or with single magnification glasses, including readers. Bifocal and trifocal lenses should not be used as they may cause a mismeasurement of pupil size by the eye tracker. We also recommend that progressive lenses be avoided, if possible, to reduce the likelihood of misreading.
- 4) Examinees observed to be 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. If such examinees are tested, the eye tracker and algorithm will more than likely determine their pupils are reacting atypically and will be given a failing EyeDetect test score for use of a countermeasure.
- 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 have been shown to resolve the issue sufficiently for testing. As long as the EyeDetect software calibrates to the eyes during the process, testing may proceed.
- 7) Examinees wearing excessive mascara, eye liner, or false eyelashes may be difficult to calibrate with the eye tracker. However, removal of such make-up usually resolves the issue.
- 8) EyeDetect does not measure heart rate, respiration, blood pressure, or skin conductance and conditions that affect those physiological measures do not generally impact EyeDetect test results.

As a matter of information, the following conditions should not negatively impact examinee suitability as long as the condition does not have a significant or dramatic impact on examinee 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) Typical use of medications such as antidepressants
- 10) Examinees as young as 11 years old have been successfully tested

The following eye or vision-related conditions may impact testing. The table below indicates the condition and possible impact, as well as potential remedies (see “Notes.”)

Condition	EyeDetect is OK	Potential Problem	Notes
• Amblyopia		Yes	
• Astigmatism	Yes		OK with glasses
• Blepharitis		Yes	
• Blepharospasm		Yes	
• Cataracts	Possible		Depends on severity
• Allergic conjunctivitis		Yes	
• Color blindness	Yes		
• Macular degeneration		Yes	
• Entropion and Ectropion		Yes	
• Strabismus		Yes	
• Glaucoma		Yes	
• Hyperopia	Yes		OK with glasses
• Lagophthalmos	Yes		
• Tearing	Yes		
• Myopia	Yes		
• Dry eye	Yes		Use lubricating drops
• Presbyopia or tired eye	Yes		OK with glasses
• Eyelid ptosis		Yes	
• Keratitis		Yes	
• Keratoconus	Yes		OK with glasses
• Diabetic retinopathy		Yes	
• Hypertensive retinopathy		Yes	
• Sjogren's syndrome	Yes		

## Summary

EyeDetect is a new and useful credibility assessment tool that can quickly, noninvasively, accurately and cost-effectively detect deception. Converus continues to improve the EyeDetect decision model (algorithm) as more tests are administered and analyzed. Computer algorithms learn as they ingest additional data sets, therefore EyeDetect’s accuracy rates will continue to improve.

EyeDetect’s low cost is compelling to organizations or individuals that cannot afford credibility assessment testing. It is an excellent tool to screen, manage, and monitor many types of offenders. EyeDetect improves outcome confidences and cost-effectively protects citizens from those in the public that have committed illegal acts or are a danger to others.

## References

### Peer-reviewed

1. Kircher, J. C., and Raskin, D. (2016) Laboratory and Field Research on the Ocular-motor Deception Test. *European Polygraph Journal*, Volume 10, Number 4 (38).
2. Cook, A. E., Hacker, D. J., Webb, A. K., Osher, D., Kristjansson, S., Woltz, D. J., & Kircher, J. C. (2012). Lyin' Eyes: Ocular-motor Measures of Reading Reveal Deception. *Journal of Experimental Psychology: Applied*, 18(3), 301-313.
3. Patnaik, P., Woltz, D., Hacker, D., Cooke, A., Francke-Ramm, M., Webb, A., and Kircher, J. (2016) Generalizability of an Ocular-Motor Test for Deception to a Mexican Population. *International Journal of Applied Psychology*, 6(1): 1-9.
4. Hacker, D. J., Kuhlman, B., & Kircher, J. C., Cook, A.E., and Woltz, D.J. (2014). Detecting deception using ocular metrics during reading. In D. C. Raskin, C. R. Honts, & J. C. Kircher (Eds.), *Credibility assessment: Scientific research and applications*. Elsevier, pp 159-216. (AUTHOR/PUBLICATION REQUIRE PURCHASE)
5. Kuhlman, B. B., Webb, A. K., Patnaik, P., Cook, A. E., Woltz, D. J., Hacker, D. J., & Kircher, J. C. (2011, September). Evoked Pupil Responses Habituate During an Oculomotor Test for Deception. Poster presented at the Society for Psychophysiological Research convention, Boston, MA. (abstract)
6. Patnaik, P., Woltz, D.J., Cook, A.E., Webb, A.K., Raskin, D.C., and Kircher, J.C. (2015, March). Ocular-motor Detection of Deception in Laboratory Settings. Meeting of the American Psychology and Law Society, San Diego, CA.
7. Webb, A. K., Hacker, D.J., Osher, D., Cook, A.E., Woltz, D. J., Kristjansson, S. K., and Kircher, J. C., (2009). Eye movements and pupil size reveal deception in computer administered questionnaires. In D. D. Schmorrow, I. V. Estabrooke, & M. Grootjen (Eds.), *Foundations of Augmented Cognition. Neuroergonomics and Operational Neuroscience (553-562)*. Berlin/Heidelberg: Springer-Verlag.
8. Webb, A. K, Honts, C. R., Kircher, J. C., Bernhardt, P.C., and Cook, A. E. (2009). Effectiveness of pupil diameter in a probable-lie comparison question test for deception. *Legal and Criminal Psychology*, 14(2), 279-292. (AUTHOR/PUBLICATION REQUIRE PURCHASE)
9. Kircher, J. C. (2018). Ocular-Motor Deception Test. In J. Peter Rosenfield, *Detecting Concealed Information and Deception* (pp. 187-212). Cambridge, MA: Academic Press. doi:10.1016/B978-0-12-812729-2.01001-6. (AUTHOR/PUBLICATION REQUIRE PURCHASE)

--

### Non-peer reviewed

10. Osher, D. (2006). Multimethod assessment of deception: Oculomotor movement, pupil size, and response time measures. (Doctoral dissertation), University of Utah, Department of Educational Psychology.
11. Webb, A.K. (2008). Effects of Motivation, and Item Difficulty on Oculomotor and Behavioral Measures of Deception. (Doctoral dissertation), University of Utah, Department of Educational Psychology. (ISBN: 9780549980032)
12. Patnaik, P. (2013). Master's Thesis: Ocular-motor methods for detecting deception: Direct versus indirect interrogation. University of Utah, Department of Educational Psychology.
13. Patnaik, P. (2015). Doctoral Dissertation: Oculomotor methods for detecting deception: Effects of practice feedback and blocking. University of Utah, Department of Educational Psychology.