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Steven Duncan
Mark Handler
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Aleksandr Motlyah
Raymond Nelson
Vitaly Shapovalov
Bruce White
Mark Zakarian

Submission of Articles

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Deadlines

This issue closed on
July 31, 2017

Deadline for September/
October 2017 issue:
September 30
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What Does the Test Result Mean?

I thought I would take a moment to write about understanding the test result again, because I find it an oft-misunderstood (or at least under-understood) concept. Some parts of this can get a bit challenging, so I will use a few pictures to help better explain things. I hope you find it useful.

Many people (including examiners) have the following thought process: “Suspect takes a polygraph, suspect fails a polygraph, and polygraph is about 85% accurate, so there is an 85% chance the suspect is lying.” Although this line of reasoning might be true under some circumstances, it is actually more likely this statement is not true. There may be a greater than 85% chance the suspect is lying or, there may be a less than 85% chance. The result really depends on the probability that the suspect was lying before taking the polygraph - something called “the prior probability” or “the prior” for short.

To begin, let’s just start with the concept of the Prior Probability. Sometimes the term “base rate” is used as a synonym for the prior probability because base rates can be used to estimate the prior. The better term is prior probability and it essentially refers to the prevalence of the target behavior or crime that you are evaluating in a person or testing population. For demonstration purposes, I will use the term prior probability of Guilt. Incidentally, if you know the prior prob-
ability of Guilt, you can estimate the prior probability of Innocence, as it is 1 - the probability of Guilt.

The following are several levels of prior probability of Guilt. Note that Guilt and Innocent refer to the ground truth state of the testing population. The red circles represent the Guilty and the green circles represent the Innocent:

**Prior of Guilt - 20%**

- 8 green circles
- 2 red circles

**Prior of Guilt - 50%**

- 5 green circles
- 5 red circles

**Prior of Guilt - 80%**

- 2 green circles
- 8 red circles
Next, let’s talk about base rates of test results in the testing population. In this case, I am referring to the pass/fail rates of the test and they can be very different depending on the population. For example, pass/fail rates are likely to differ among sex offender maintenance screening, sex offender monitoring screening, public safety pre-employment screening, periodic security screening, diagnostic criminal testing, etc. Essentially, pass/fail rates vary depending on the test used, the target behaviors selected, and the test data analysis model used. Here is something important to remember—the pass/fail rate of a test is NOT the base rate or prior probability of Guilt (lying) or Innocence (truth-telling). Many people incorrectly conflate these two concepts (mix them together.) The pass/fail base rates will be comprised of those tests that were correct plus those were incorrect. Most we get right, but some we get wrong.

The prior probability of Guilt refers to the condition you have at the beginning of the test—how many in the testing population are Guilty and how many are Innocent. Recall, the test result is a combination of the number of Guilty or Innocent that are correctly identified and how many errors occurred. An accurate, reliable test will make more correct identifications than errors over time. In short, when giving someone a test result, we should be confident that the subject was lying, given that they failed the test, or visa-versa.

This concept has been called the “Outcome Confidence” and it describes the level of confidence that you have in the test result. The more formal names for this is positive predictive value (PPV) and negative predictive value (NPV). Basically this concept provides the consumer or end-user with a value that can be used to update the assessment of the test subject. Recall we had a prior probability of Guilt estimate before taking the test. After taking the test, you can have an updated estimate of Guilt or Innocence because of the test result. But how can you derive this post-test estimate?

**Bayes’ Theorem**

Bayes’ Theorem is a formula that can be used in polygraph testing to estimate how much a test result changes the Outcome Confidence of Guilt or Innocence. Bayes’ Theorem takes what is known before the test, applies what is known about the test, and updates the knowledge about the subject, given the test results.

Here is Reverend Bayes and his theorem applied to polygraph testing.
p(deceptive | SR) =
\[ p(SR | deceptive)^* p(deceptive) \div \]
\[ p(SR | deceptive)^*p(deceptive) + p(SR | truthful)^*p(truthful) \]

\[ p(truthful | NSR) = \]
\[ p(NSR | truthful)^* p(truthful) \div \]
\[ (p(NSR | truthful)^* p(truthful) + p(NSR | deceptive)^*p(deceptive) \]

I will now dissect this equation and to help better understand the meaning. Let’s look at the equation for the Outcome Confidence in a failed polygraph test (the one in red ink next to the picture of Reverend Bayes). To do this, I will need to define some terms and concepts.

a) True Positives = the sensitivity of the test. This refers to the number of Guilty subjects properly identified by failing the test.
b) False Positives = refers to the number of errors made on Innocent subjects that had a positive test result (failed the lie detection test).
c) True Negatives = the specificity of the test. This refers to the number of Innocent subjects properly identified by passing the polygraph.
d) False Negatives = refers to the number of errors made on Guilty subjects that ended up passing the test.
e) SR = Significant Response, a positive test result, or failed the test.
f) NSR = No Significant response, a negative test result, or passed the test.
g) p(deceptive | SR) = “The probability the subject is deceptive, given that they failed the test.”
h) p(SR | deceptive) = “The probability the subject would fail the test if they were deceptive.” This is estimated by the test sensitivity.
i) p(deceptive) = refers to the prior probability of Guilt before the subject took the test, sometimes called the “base rate of Guilt or lying.”
j) p(SR | truthful) = refers to the prob
ability of failing the test, given that the subject is telling the truth (false positive rate).

k) \( p(\text{truthful}) \) = refers to the prior probability of Innocent before they took the test, sometimes called the “base rate of Innocent or truth.”

Now consider a plain English explanation of Bayes’ equation applied to a failed polygraph test.

\[
p(\text{deceptive} \mid SR) = \frac{p(SR \mid \text{deceptive}) \cdot p(\text{deceptive})}{p(SR \mid \text{deceptive}) \cdot p(\text{deceptive}) + p(SR \mid \text{truthful}) \cdot p(\text{truthful})}
\]

Question: “What is the probability the subject is deceptive, given they failed the test?”

\[
p(\text{deceptive} \mid SR)
\]

Answer:

It is the probability someone will fail the test if they are lying (sensitivity) times the prior probability (or base rate of Guilt.)

\[
p(SR \mid \text{deceptive}) \cdot p(\text{deceptive})
\]

DIVIDED BY

The probability someone will fail the test if they are lying (sensitivity) times the prior probability (or base rate) of Guilt.

\[
p(SR \mid \text{deceptive}) \cdot p(\text{deceptive})
\]

PLUS

The probability someone will fail the test if they are telling the truth (false positive rate) times the prior probability (or base rate) of Innocent.

\[
p(SR \mid \text{truthful}) \cdot p(\text{truthful})
\]
Stated another way, it is equal to the True Positives ÷ All Positives while taking into consideration the prior probability (or the base rate) of deception and truth telling.

Obviously, you should do the same thing to estimate the Outcome Confidence in a passed polygraph result as well. To do that, take the equation in green next to Reverend Bayes’ picture shown above. In that case it would be True Negatives ÷ All Negatives and account for the prior probabilities (or base rates.)

You should see now that the number and type of errors made depends on the accuracy PLUS the prior probability of Guilt (or base rate) of the testing population. If you are testing mostly Guilty subjects, you will make more errors on Guilty subjects. If there are more Innocent subjects in the testing pool, then you will make more errors on them.

You can use estimates from the APA Meta-analytic review for sensitivity, specificity, false positive and false negative rates for a given technique or for all techniques combined to calculate the Outcome Confidence. But one thing you have to do is to estimate a prior probability of Guilt. Interestingly, you can do this based on historical testing data and Gubin et al. wrote an article about how to do this a couple of magazines ago.

Pictures versus a thousand (or more) words

OK, now I will use the “picture is worth a thousand words” approach to visually demonstrate these concepts. Let’s assume there is a polygraph test that is 90% accurate in identifying Guilty and Innocent subjects and has no Inconclusive results. Also assume the prior probability of Guilt is 50%, or .5. That means the Guilty and Innocent subjects are evenly split 50/50 in the testing population.

<table>
<thead>
<tr>
<th>Ground Truth</th>
<th>Pass Test</th>
<th>Fail Test</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innocent</td>
<td>450 (TN)</td>
<td>50 (FP)</td>
<td>500</td>
</tr>
<tr>
<td>Guilty</td>
<td>50 (FN)</td>
<td>450 (TP)</td>
<td>500</td>
</tr>
<tr>
<td>Totals</td>
<td>500</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>Outcome Confidence (NPV &amp; PPV)</td>
<td>0.9 (NPV)</td>
<td>0.9 (PPV)</td>
<td></td>
</tr>
</tbody>
</table>
In the table above, the Outcome Confidence mirrors the test accuracy (sensitivity and specificity) and that is great!

In the image below, I will show the same concept in a “testing funnel.”

In this example, there were 500 Guilty and 500 Innocent subjects tested. Of the 500 subjects that passed the test, the test correctly identified 90% —so the Outcome Confidence is .9 or 90%. You can tell the end-user or consumer that you are 90% confident that those who passed the test were telling the truth.”

**Real-World” Estimate Examples**

Now, let’s take a look at what happens when we use the estimated accuracy and error rates for all polygraph techniques from Table 2 in the Meta-analytic review APA, 2012) and vary the base rate.

<table>
<thead>
<tr>
<th>PDD- All techniques (APA, 2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass Test</td>
</tr>
<tr>
<td>Innocent</td>
</tr>
<tr>
<td>Guilt</td>
</tr>
</tbody>
</table>
**With an even base rate**

Starting with even base rates, assume that you test 500 Guilty and 500 Innocent subjects. Of the 475 that failed the test, the test correctly identified 85%. The Outcome Confidence is .85. You can tell the end-user or consumer that you are 85% confident that those who failed this test, under these conditions, are probably lying. Here is the testing funnel.

![Testing Funnel Diagram]

**When base rates are lower**

Now we will apply the testing funnel approach to another “real-world” polygraph testing situation: PCSOT monitoring testing, a screening approach currently taught in APA training programs.

Note: I am not advocating in favor of, or against, this screening tool. I am simply using this because I read a recent article in Federal Probation (Cohen & Spidell, 2016) that provides what seem to be reliable estimates of the base rate of the target for this testing. In this article, they estimated the 3-year recidivism rate for a new sex crime by federally convicted sex offenders to be 2.8%. This means that in a group of 1000 sex offenders, only 28 are guilty of re-offending and 972 are innocent. As you can imagine, with these ratios, the test is likely going to have a large number of false positives simply because of the large number of innocent people in the testing population.

Using the 2.8% value as the prior prob
when base rates are lower.

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Note: I am not advocating in favor of, or against, this screening tool. I am simply using this because I read a recent article in Federal Probation (Cohen & Spidell, 2016) that provides what seem to be reliable estimates of the base rate of the target for this testing. In this article, they estimated the 3-year recidivism rate for a new sex crime by federally convicted sex offenders to be 2.8%. This means that in a group of 1000 sex offenders, only 28 are guilty of reoffending and 972 are innocent. As you can imagine, with these ratios, the test is likely going to have a large number of false positives simply because of the large number of innocent people in the testing population.

Using the 2.8% value as the prior probability (base rate) and the values from Table 2 in the Meta-analytic review, the testing funnel would look like the following:

That suggests that a failed test under these circumstances provides an Outcome Confidence of about 14%. In other words, of those who failed, 14% were Guilty subjects and the rest were Innocent. This implies that a failed test result here may not be very helpful to the end-user or consumer. If a person fails the monitoring test under these conditions, you can be about 14% confident they were actually reoffending.

Discussion

This phenomenon is often surprising to examiners and end users. As stated earlier, a common misunderstanding exists that if a person takes a test and fails the test, assuming the test is 85% accurate, there is an 85% chance the person is lying about the relevant question targets. As you can see in the examples, that may be true if the prior probability is near chance (50%). But once that prior starts moving away from 50%, Outcome Confidence changes.

In conclusion, this review of Bayes’ Theorem should help you better understand the phenomenon that prior probabilities (base rates) do affect Outcome Confidences. As such, your clients need to also be aware of this in order to properly assess risk and to consider actions to be taken with the test results derived. This concept may put you in the uncomfortable position of having to estimate the prior proba-
bility of Guilt (base rate) but it is a vitally important consideration to appreciate what testing result really mean.

Credibility assessment professionals must learn to understand Outcome Confidence and be able to explain it as it relates to the test result. Responsible professionals have a duty to understand and report testing results and the error estimate surrounding that result. I am hoping the membership will agree with me and request training in these areas at state and national seminars. The days of “He failed the heck out of the test” are long behind us. The math is not difficult for most examiners I have met, and those that make an effort to grasp these concepts do quite well.

As always, I am here for you and am willing to help you understand and master these concepts. Please feel free to email me at editor@polygraph.org

Thanks for taking time to read this.

References:


2017 APA Elections

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2017 APA Elections Schedule

APA will hold its annual election for Board offices in June. If you are interested in running for office, please take note of the positions being voted this year:

- President Elect (1 year)
- Director 1 (2 years)
- Director 3 (2 years)
- Director 5 (2 years)
- Director 7 (2 years)

Applicants must specify which of the five offices he or she is a candidate. Candidates may run for only one office per year.

Below are important dates to remember:

- **April 1 – April 30:** Period to submit nominations and self-nominations in writing to the National Office. Nominations must include a cover letter specifying for which office the candidate is vying.
- **May 1 – 7:** Validation of candidates’ eligibility to hold APA office.
- **May 7:** Last day to submit a candidate statement up to 500 words for the APA Magazine and the APA website (editor@polygraph.org)
- **June 7:** Candidacy letters published on the APA website and in the APA Magazine.
- **June 17:** Email notification of elections (Ensure your email address is current on the APA website; www.polygraph.org)
- **June 18 - 24:** Electronic elections.
- **June 26:** Posting of results on the APA website.
- **July 9 - 15:** Runoff elections, if necessary.
- **July 17:** Notification to winners. Posting of final election results.
- **August 31:** Officers sworn in at the APA Annual Banquet.

For additional information, contact Mark Handler at editor@polygraph.org or (859) 539-0705.
## Total Voters: 2573

<table>
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<th>Platform</th>
<th>Choice</th>
<th>Votes</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>President-elect</td>
<td>Steven Duncan</td>
<td>199</td>
<td>61 %</td>
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<tr>
<td></td>
<td>John Palmatier</td>
<td>84</td>
<td>26 %</td>
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<td></td>
<td>Daniel Mangan</td>
<td>43</td>
<td>13 %</td>
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<tr>
<td>Director 1</td>
<td>Pam Shaw</td>
<td>298</td>
<td>100 %</td>
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<tr>
<td>Director 3</td>
<td>George Baranowski</td>
<td>174</td>
<td>58 %</td>
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<td>Robert Smith</td>
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<td>42 %</td>
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<td>Director 5</td>
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<td>Director 7</td>
<td>Brian Morris</td>
<td>106</td>
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<td>Darryl Bullens</td>
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<td></td>
<td>Gary Davis</td>
<td>90</td>
<td>31 %</td>
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<td>Director 7 runoff</td>
<td>Total voters: 2591</td>
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<tr>
<td></td>
<td>Brian Morris</td>
<td>167</td>
<td>57 %</td>
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<tr>
<td></td>
<td>Darryl Bullens</td>
<td>128</td>
<td>43 %</td>
</tr>
</tbody>
</table>
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Nayeli Hernandez and Emma, Indiana

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Virginia Beach, VA

National Polygraph Academy

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Sept 11 - November 17, 2017 (TBA)

PCSOT Courses:
August 14-18, 2017 (Amarillo, TX)

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(Cape Coral, FL)
September 5 - November 10, 2017
January 8 - March 16, 2018
May 7 - July 13, 2018
September 4 - November 9, 2018

Advanced Examiner's Course
November 13 - 17, 2017 (Boise, ID)
December 4 - 8, 2017 (Lafayette, IN)
March 26 - 30, 2018 (Cape Coral, FL)
July 23 - 27, 2018 (Cape Coral, FL)

American International Institute of Polygraph

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2017 Tri-State Polygraph Conference (GPA, NCPA, SCAPE)
October 3-5 2017
(Tybee Island, GA)

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**CUTOFF DATE** for hotel reservations is **10/2/17** Individual departure dates will be reconfirmed upon check-in. (5 DAY CANCELLATION notice required)

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$275 Non-Member

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*must be a paid up member of VPA

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<tr>
<td>DPOR representative</td>
</tr>
<tr>
<td>Ethics, Pre-Employment, LEPET – Steve Duncan, APA President-Elect</td>
</tr>
</tbody>
</table>

**CONTINUING EDUCATION HOURS**
When you attend this seminar, you receive up to 16 CEHs (Continuing Education Hours) approved by the American Polygraph Association and the Federal Certification Program for Continuing Education and Training.

**APA Cancellations Refund Policy:**
Cancellations received in writing prior to **10/2/17** will receive a full refund. Persons canceling **after 10/2/17** will not receive a refund but will be provided with the handout material.

**Tax Deductions:**
All expenses of continuing education (including registration fees, travel, meals and lodging) taken to maintain and improve professional skills are tax-deductible subject to the limitations set forth in the Internal Revenue Code.

( The registration fee includes professional instruction, seminar materials, AM and PM Refreshment Breaks, Continental Breakfast and Lunch )

**LUNCH ATTENDANCE**

<table>
<thead>
<tr>
<th>THURSDAY</th>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>FRIDAY</td>
<td>YES</td>
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**ADDITIONAL $50.00 FOR WALK-INS**

( ) CHECK MADE PAYABLE TO: AMERICAN POLYGRAPH ASSOCIATION is enclosed  
( ) CHARGE $__________ TO MY: VISA ( ) MC ( ) Discover ( )

Card number ___________________________________________ (CVV2) __________ EXP: __________
(CVV2 is a 3 digit number found on the back of your VISA or MC card) (We do not accept AmEx)

SIGNATURE _____________________________________________

CES-Virginia Beach, VA (Nov 2-3, 2017) We can not possibly reach everyone who would be interested in taking part if this seminar. Please help us by making copies of the page for your co-workers and business associates. Thank you for your assistance.
<table>
<thead>
<tr>
<th>SUNDAY, AUGUST 27, 2017</th>
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<tbody>
<tr>
<td><strong>CLASSROOM A</strong></td>
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<tr>
<th>1:00 - 2:00 PM</th>
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| Avoiding the Pitfalls: Ethics for Polygraph Examiners  
Steve Duncan, APA Director | You Want Me to Ask What?  
Test Question Construction  
Steve Duncan, APA Director |

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<tr>
<th>SCHOOL DIRECTOR’S MEETING</th>
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| 1:00 - 3:00 PM  
(ROOM TO BE ANNOUNCED) |

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<tr>
<th>APA WELCOME RECEPTION</th>
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<tr>
<td>MONDAY, AUGUST 28, 2017</td>
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<tr>
<td>CLASSROOM A (disponible en Español)</td>
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<tr>
<td>8:00 - 9:30 AM</td>
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<tr>
<td>Call to Order</td>
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<tr>
<td>Presentation of Colors</td>
</tr>
<tr>
<td>The National Anthem</td>
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<tr>
<td>Pledge of Allegiance</td>
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<tr>
<td>Taps</td>
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<tr>
<td>Invocation</td>
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<tr>
<td>Welcome to Las Vegas</td>
</tr>
<tr>
<td>Special Guest Speaker</td>
</tr>
<tr>
<td>Seminar Program Chair</td>
</tr>
<tr>
<td>9:45 - 12:00 NOON</td>
</tr>
<tr>
<td>Gordon L. Vaughan, Moderator</td>
</tr>
<tr>
<td>Panel: Don Krapohl, Pat O'Burke, Raymond Nelson, Dr. David Raskin</td>
</tr>
<tr>
<td>12:00 NOON - 1:00 PM</td>
</tr>
<tr>
<td>1:00 - 4:00 PM</td>
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<tr>
<td>Donald J. Krapohl</td>
</tr>
<tr>
<td>2:45 - 3:00 PM Break Sponsored by: <strong>LAFAYETTE INSTRUMENT CO. INC.</strong></td>
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<tr>
<td>4:00 - 5:00 PM</td>
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<tr>
<td>J. Patrick O'Burke</td>
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### THURSDAY, AUGUST 31, 2017

#### 7:30 - 8:00 AM Break Sponsored By:

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<thead>
<tr>
<th>CLASSROOM A</th>
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<tbody>
<tr>
<td><strong>8:00 - 12:00 NOON</strong></td>
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<tr>
<td>The Probable Lie Pre-Test Interview</td>
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<tr>
<td>Milton O. &quot;Skip&quot; Webb</td>
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<tr>
<td>APA Past President</td>
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<tr>
<th>CLASSROOM B</th>
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<tbody>
<tr>
<td><strong>8:00 - 12:00 NOON</strong></td>
</tr>
<tr>
<td>Lessons Learned About Testing Serious Sexual Assaults and Ethics</td>
</tr>
<tr>
<td>Charles Slupski, APA Past President, AIIP School Director</td>
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<td>PCSOT</td>
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<tr>
<th>CLASSROOM C</th>
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<tbody>
<tr>
<td><strong>8:00 - 3:00 PM</strong></td>
</tr>
<tr>
<td>Developing and Implementing an Internal Quality Control Policy</td>
</tr>
<tr>
<td>J. Patrick O'Burke</td>
</tr>
<tr>
<td>APA President</td>
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<tr>
<td>TDLR Approval pending</td>
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</tbody>
</table>

#### 9:45 - 10:00 AM Break Sponsored By:

#### 12:00 Noon - 1:00 PM Lunch On Your Own

<table>
<thead>
<tr>
<th>1:00 - 2:45 PM</th>
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<tbody>
<tr>
<td>Legal Issues</td>
</tr>
<tr>
<td>Gordon L. Vaughan, Esq.</td>
</tr>
<tr>
<td>APA General Counsel</td>
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<tr>
<th>1:00 - 5:00 PM</th>
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<tbody>
<tr>
<td>Interview and Interrogation</td>
</tr>
<tr>
<td>Marty Woods</td>
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<tr>
<td>SA FBI</td>
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<td>Developing and Implementing an Internal Quality Control Policy</td>
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<tr>
<td>J. Patrick O'Burke</td>
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<tr>
<td>APA President</td>
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<tr>
<td>TDLR Approval pending</td>
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#### 2:45 - 3:00 PM Break Sponsored By:

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<th>3:00 - 5:00 PM</th>
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<tbody>
<tr>
<td>Doug Williams: The Fall of a Countermeasure Advocate</td>
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<tr>
<td>Jorge Pereira</td>
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<tr>
<td>SA FBI</td>
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<tbody>
<tr>
<td>Interview and Interrogation</td>
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<tr>
<td>Marty Woods</td>
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<td>SA FBI</td>
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<th>3:00 - 5:00 PM</th>
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<tbody>
<tr>
<td>Testing the Adult and Juvenile Sex Offender and Their Differences</td>
</tr>
<tr>
<td>Sabino Martinez</td>
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<tr>
<td>APA Director</td>
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<tr>
<td>PCSOT</td>
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</tbody>
</table>

### APA ANNUAL BANQUET AND AWARDS

- **6:30 - 7:00 PM COCKTAILS**
- **7:00 PM DINNER**
## FRIDAY, SEPTEMBER 1, 2017

<table>
<thead>
<tr>
<th>Time</th>
<th>Classroom A</th>
<th>Classroom B</th>
<th>Classroom C</th>
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<tbody>
<tr>
<td>7:30 - 8:00 AM</td>
<td>Break Sponsored By:</td>
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<tr>
<td>8:00 - 12:00 NOON</td>
<td>Pretest Interview Using Directed Lie</td>
<td>8:00 - 10:00 AM Polygraphing Adolescents in a Residential Treatment Setting, Research Supporting Use of the Polygraph in a Clinical Based Model to Advance Treatment and Improve and Heal Relationships</td>
<td>8:00 - 10:00 AM Progress of Research Regarding Polygraph in Colombia: A Look to the Automation and the Acquaintance Test Using Images</td>
</tr>
<tr>
<td></td>
<td>Gary F. Davis, APA Director</td>
<td>Shawn Brooks, Executive Director Oxbow Academy</td>
<td>Manuel Novoa, Director Latin American Polygraph Institute</td>
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<tr>
<td>9:45 - 10:00 AM</td>
<td>Break Sponsored By:</td>
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<tr>
<td>12:00 Noon - 1:00 PM</td>
<td>Lunch On Your Own</td>
<td>10:00 AM - 12:00 NOON Current Controversies in PSCOT with Juveniles</td>
<td>10:00 AM - 12:00 NOON Practice of Polygraph Use in Court Proceedings in Russia and the Eurasian Region</td>
</tr>
<tr>
<td></td>
<td>(CONT'D)</td>
<td>John Pickup, Intermountain Polygraph LLC</td>
<td>Said Khamzin, APA Member</td>
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<tr>
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<td>Pretest Interview Using Directed Lie</td>
<td>PCSOT</td>
<td>Yaroslava Komissarova, PhD</td>
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<td>Gary F. Davis, APA Director</td>
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<tr>
<td>12:00 Noon - 1:00 PM</td>
<td>Lunch On Your Own</td>
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<tr>
<td>1:00 - 3:00 PM</td>
<td>Why It's Not Lie Detection, But Instead Memory Detection:</td>
<td>1:00 - 3:00 PM Polygraph 101 - Back to the Basics</td>
<td>1:00 - 3:00 PM DLC Single Issue Technique</td>
</tr>
<tr>
<td></td>
<td>What Modern Science Says About Credibility Assessment</td>
<td>Darryl Starks, APA Director</td>
<td>Rodolfo Prado, APA Member</td>
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<td>John Palmatier, PhD</td>
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<td>Slattery Associates, Inc.</td>
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<tr>
<td>3:00 PM</td>
<td>CLOSING REMARKS</td>
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<td></td>
<td>James B. McCloughan, APA President</td>
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### APA Magazine 2017, 50 (4)
YOU NEED ACCESSIBLE AND PROVEN POLYGRAPH SOLUTIONS

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Tel: (765) 423-1505
Hello, APA Members. As we near the end of summer, things are still busy within the APA. Your APA Office Staff and Board of Directors are still working on a number of projects including arranging for additional Regional Seminars and preparing for the 2017 Annual Seminar in Las Vegas.

I do want to take this opportunity to thank the Members who ran for office in the recent election and voice appreciation to the Members who took the time to participate in the voting process.

The Ethics and Grievance Committee has resolved several cases. The majority of our complaints continue to be unfounded. The number of complaints we are receiving appears to have declined combined with the number unfounded is a good sign that our examiners are following the by-laws and proper procedures. I urge you, as a Member, to follow the Standards of Practice in order to protect our profession. Work continues with the committee policy.

As a Board Member I have continued to assist Members with issues as requested and I am here to help with problems if I can. I have continued working on projects with other Board Members on quality assurance and other issues.

As always, feel free to call or email me if I can be of assistance to you.

In a few short weeks the annual seminar will be here. Or, rather, we will be at the seminar. Already the seminar registration and attendance is shaping up to be among the largest of all APA conferences. So either the conference agenda is absolutely engaging and compelling or there is some other intrinsic attractive value that Las Vegas itself may have added to the situation. Either way it’s going to be a great conference and I hope to meet as many people as possible. Your elected servants at the Board continue to work diligently in preparation, making sure all the details are accounted for and arrangements are made.

**From the Board**

**Steven Duncan**
**Director**

**Raymond Nelson**
**Director**
In other work, the Board has continued to prepare to move forward with ASPA to increase the stature of our association as an accreditation body for polygraph training programs. That will undoubtedly be an important aspect of the future of our profession as we seek to continue to advance the recognition of polygraph testing and the polygraph profession as the most important and effective form of scientific credibility assessment testing – in part due to the professionalism of APA members and the professional infrastructure of the APA. However, it is well known by now that polygraph is no longer the only form of scientific credibility assessment testing.

Although I am presently not involved in, and know little about other technologies, I do not view the emergence of other technologies as inherently bad or problematic. To be clear, the existence of other scientific tests for lie detection and credibility assessment is a potential challenge to us both scientifically and economically. No longer are polygraph professionals competing only with each other. And no longer can thinking-persons realistically entertain the notion that all physiology is mere chaos with no useful correlation with deception or truth-telling. Also, no longer can polygraph professionals sit on the fence about whether polygraph is or is not a scientific test. It is. If not, then we will be forced to watch the economics of scientific lie detection shift away from the polygraph and toward other technologies. Of course there will always be a need for good interviewing and interrogation – because there will always be value in the information obtained from these activities. But it will be unwise to equivocate about the scientific value of the test result itself. For this reason, things like continuing education and annual seminars are vitally important. In the history of the world, culture that existed in close proximity and competition with each other have tended to advance the most – either they remain competitive in terms of technology, communication, and education, or they cease to exist. In contrast, cultures that exist in geographically safe locales with comfortable resources very stable economies independent of other economies have tended to have less need for continued advancement. Some have even suggested the major differences between cultures seem to have more to do with geography than any other factors. Regardless, competition makes us stronger.

Packed in among all the other activities at the Board this year, is the adoption of a new Model Policy for Quality
Assurance. I view this as a substantial achievement – both because of the need for more order and less chaos in the QA/QC space and because of the way that the new Model Policy came together. The topic of quality control itself is huge and complex, with potentially every variety of pre-conceived expectations based on limited experience in a particular segment of the profession. It is additionally complex because of the potential invitation for power-and-control dynamics to begin to occur – sometimes as a result of economic interest and sometimes mere ego interests. In jest, I ask: who wouldn’t want to be the king-of-polygraph. But in reality a well-crafted quality assurance protocol should not be – and in reality cannot be - premised on a single oracle, or on “guru-ism” or any other reflection of pseudoscience. The challenge at the Board level was to draft a policy that will be as helpful to polygraph professionals in private practice as it is to those in law enforcement and government work, and to achieve a policy that will be helpful across the variety of state and national boundaries that sometimes include widely varying statutes and judicial attitudes. In the end the Model Policy is a simple and factual document that outlines the process of evaluating whether an exam was completed or conducted in compliance with APA standards of practice or other best practices.

Like other Model Policies, this one is intended to be a guide of point of departure for the development of local standards of practice that will more precisely fit the available needs and resources. Where there is disagreement between the model policy and local regulations, it is intended to be clear that local regulations should prevail. Among the most important aspects of the new Model Policy for Quality Assurance is that it continues to advance the emphasis on evidence-based practices. In practical terms this means that there is no value to the profession as a whole and no value to the individual professional to give emphasis to dogma or tradition that is not based in scientific evidence.

It is important to appreciate that the model policy is a policy not a program. Without some agencies need a quality control program, and these will be – and have already – faced the need to devote financial, personnel and physical resources to such a program. For better or worse the authority of the APA to require a quality control program in every locale is limited – it cannot be done. Instead, the APA can provide leadership and guidance
by providing structure as to how to do a QA or QC review when it is necessary to do so. Because it is based on a concern for evidenced-based practice and compliance with standards of practice that are based in evidence, the end process is made less complex. Ultimately the goal of QA and QC is to support good polygraph work wherever possible, and to deter the tendency to become complacent or lackadaisical about compliance.

In reality, all polygraphs that are suggested for introduction as a basis of information or evidence for any legal or judicial or administrative proceeding are likely to be subject to quality control – by the opposing counsel’s expert. The goal of this model policy is simply to reduce needless and unproductive fault-finding, and to help people understand what the opposing expert is likely to conclude about compliance with evidence-based practices. It is not the goal of this model policy to make examiners more vulnerable to attack or criticism. I believe the model policy has succeeded. And of course, it is possible that there will be improvements as we gain more experience in this area – so please let us know your thoughts.

Hope to see you in Las Vegas.
Secretary's Report of Board Actions

Submitted by Lisa Jacocks

This report covers the time period of November 2016 through July 2017

November 10, 2016 – BOD Meeting

- Approved the Chicago Palmer House as the 2021 seminar location
- Approved the Divisional Affiliate membership of the Minnesota Polygraph Association (MnPA)
- Approved the donation of $1000 to the AAFS General Selection Reception

March 17-18, 2017 – BOD Meeting

- Approved the waiver request of the Northeast Counterdrug Training Center Polygraph Institute
- Approved charging vendors $500 for a two-hour presentation block at the 2017 APA Annual Seminar and no presentation blocks will be made available for for-profit vendors after the 2017 APA Annual Seminar
- Approved New Orleans, Louisiana as the 2020 APA Annual Seminar location subject to acceptable contract negotiation
- Approved the addition of 3.1.a.i.1 to the bylaws
- Approved the accreditation of the Canadian Police College Polygraph Training School retroactive to September 12, 2016
- Approved the accreditation of the Escuela Nacional de Poligrafia (ENPOL) retroactive to September 26, 2016
• Approved the accreditation of the Centro de Investigacion Forense y Control de Confianza S.C. retroactive to September 6, 2016

• Approved the accreditation of the Behavioral Measures United Kingdom polygraph program retroactive to January 4, 2017

• Approved the travel, lodging and per diem expenses for two (2) AAFS members to attend the APA Annual Seminar in Las Vegas on Monday and Tuesday

• Approved changing the name of the Polygraph journal to Polygraph & Forensic Credibility Assessment: A Journal of Science and Field Practice

May 16, 2017 – BOD Meeting

• Approved the accreditation of the National Academy of Polygraph of the National Police of Colombia retroactive to September 5, 2016

• Approved the accreditation of the Northeast Counterdrug Training Center Polygraph Institute retroactive to January 24, 2017

July 11, 2017 – BOD Meeting

• Approved the accreditation of the Latin American Polygraph Institute retroactive to February 6, 2017

• Approved the accreditation of the Escuela Nacional de Poligrafia (National Polygraph School) retroactive to March 6, 2017

• Approved the EAC Inspector’s Operational Policy and that any conflict with the APA EAC Accreditation Standards Version 2.02 would be negated

• Approved the Divisional Affiliate membership of the Polygraph Association of Nigeria
Recommendations to the Membership

Dear Member,

The Board of Directors (BOD) has decided to present three items at the General Membership meeting in Las Vegas, August 29, 2017, 10:00 am, for your consideration.

1. The BOD recommends removing the exception to having a college degree from the Bylaws. See redlined version below.

3.2 Member

3.2.a Members are those persons who:

3.2.a.i Have served as an Associate for at least twenty-four (24) months immediately prior to Member status;

3.2.a.ii Certify they have read and are in compliance with the APA’s Code of Ethics and APA Standards of Practice;

3.2.a.iii Have completed not fewer than two-hundred (200) field polygraph examinations using a validated polygraph technique;

3.2.a.iv Within the thirty-six (36) months preceding their application to become a Member have completed a minimum of sixty (60) hours of continuing education on topics directly related to polygraph testing, including at least one (1) APA Annual Seminar, during the time they are an Associate; and

3.2.a.v Have received a minimum of a Baccalaureate Degree from a college or university accredited by an accreditation board recognized by the United States Department of Education or the Council for Higher Education Accreditation; or an equivalent degree from a college or university outside of
the United States recognized by the international educational community as meeting similar standards.

Following the APA Annual seminar in September, 2019 the provisions for exception to having a college degree contained under 3.2.a.v.1 and 3.2.a.v.2 will expire, and will be removed as an exception to the standards under 3.2.a.v and will therefore require a college degree to advance from Associate to Member.

or,

3.2.a.v.1 Have attended at least sixty (60) hours of accredited college hours, and;

3.2.a.v.2 Satisfactorily completed an APA approved qualifying examination attesting to their knowledge of, competence in, the administration of polygraph procedures;

2. The BOD recommends changes to Bylaws regarding election schedule and time in office for President, President-Elect, and Past-President (Chairman of the Board). See the redline proposal below.

Old

4.5 Vacancy.

In the event of death, resignation or the inability to act of any Director, the Board of Directors shall immediately appoint any voting Member to serve the unexpired term of the deceased, resigned or disabled Director. A vacancy in the office of the President shall be filled by the immediate succession to that office of the President-Elect for the balance of the term remaining, and one (1) year thereafter, or until a successor is duly qualified. Any vacancy in the office of the Immediate past President will result in the duties of that office being assumed by the President, who will retain rights as a voting member of the Board while serving as Chairperson of the Board for the unexpired term, or until a successor as President is duly qualified. A vacancy in the office of the President-Elect will be filled by vote of the Board of Directors from among its members, or any duly qualified Member in good standing. Nomination of one (1) or more candidates may be made by any voting member of the Board of Directors, and unless there is only one (1) candidate,
where voice vote shall suffice, voting shall be by secret ballot with a majority vote of those voting necessary to elect. In the event no single candidate receives a majority vote on the first or subsequent ballots, the two (2) candidates, plus ties, receiving the most votes shall be voted on the next ballot. The person elected shall serve the balance of the term remaining and automatically shall become the President at the next annual General Membership Meeting.

New

4.5 Vacancy.

In the event of death, resignation or the inability to act of any Director, the Board of Directors shall immediately appoint any voting Member to serve the unexpired term of the deceased, resigned or disabled Director. A vacancy in the office of the President shall be filled by the immediate succession to that office of the President-Elect for the balance of the term remaining, and two (2) years thereafter, or until a successor is duly qualified. Any vacancy in the office of the Immediate past President will result in the duties of that office being assumed by the President, who will retain rights as a voting member of the Board while serving as Chairperson of the Board for the unexpired term, or until a successor as President is duly qualified. A vacancy in the office of the President-Elect will be filled by vote of the Board of Directors from among its members, or any duly qualified Member in good standing. Nomination of one (1) or more candidates may be made by any voting member of the Board of Directors, and unless there is only one (1) candidate, where voice vote shall suffice, voting shall be by secret ballot with a majority vote of those voting necessary to elect. In the event no single candidate receives a majority vote on the first or subsequent ballots, the two (2) candidates, plus ties, receiving the most votes shall be voted on the next ballot. The person elected shall serve the balance of the term remaining and automatically shall become the President at the next annual General Membership Meeting.

Old

7.1 President.

The President shall serve as President for one (1) year and subsequently and automatically for (1) year as Immediate Past President. The President may
not serve as President for consecutive terms. The President shall:

New

7.1 President.

The President shall serve as President for two (2) years and subsequently and automatically for two (2) years as Immediate Past President. The President may not serve as President for consecutive terms. The President shall:

Old

7.2 President-Elect.

The President-Elect shall serve as President-Elect for one (1) year and shall automatically become President after his/her term as President-Elect terminates. The President-Elect shall:

New

7.2 President-Elect.

The President-Elect shall serve as President-Elect for one (1) year, which shall be elected every other year, and shall automatically become President after his/her term as President-Elect terminates. The President-Elect shall:

Old

7.3.a Serve as Immediate Past President for one (1) year and automatically shall become Immediate Past President after his or her term as President terminates;

New

7.3.a Serve as Immediate Past President for two (2) years and automatically shall become Immediate Past President after his or her term as President terminates;

3. The BOD recommends adding an Education and Training Coordinator as an Ex-Officio member of the board. See the reason for the recommendation below.

The Education Accreditation Committee (EAC) is a very busy committee that coordinates the program inspections, verifies that the requirements of in-
structors is met, that the program is completing and submitting the required paperwork, etc. Training a new person to be the committee chair each year takes a lot of time and is nearly impossible. This is a position that is a necessity for our continued growth.

Please be prepared to vote on the above issues at the General Membership meeting.

Sincerely,

Lisa Jacocks, Secretary
American Polygraph Association
STATEMENT OF PURPOSE: This Model Policy for Quality Assurance is provided to assist field practitioners and other professionals in the determination of compliance with established standards and best practices. Examiners should know and adhere to all legal requirements and practice regulations in their local jurisdiction. This Model Policy may serve as a point of reference for the development of quality assurance practices and requirements for an agency or local jurisdiction. In case of any conflict between this Model Policy and any local practice requirements the local regulations should prevail. Examiners who work in jurisdictions and programs without local regulations may refer to this Model Policy as a guide.

1. DEFINITIONS

1.1 Quality Assurance (QA): Quality assurance activities are varied and can include requirements for training, experience, continuing education, professional certification, program accreditation and program evaluation activities. Quality assurance activities can also include quality control programs intended to ensure compliance and identify substandard work products. Quality assurance for the purpose of this model policy refers to activities related to the review of a single polygraph examination for compliance with evidence-based field-practice standards and best practices. Quality assurance reviews of this type can include self-review, internal review by another examiner within the same agency, external review by an independent examiner, or blind review in which the reviewer is not informed of the examiner’s conclusion or other case facts.
2. EXAMINER RESPONSIBILITIES

2.1 All polygraph examinations should be conducted in compliance with applicable law, APA Standards of Practice and best practices.

2.2 Examiners should maintain all case materials, including referral information, interview notes, test data, analysis, results, examination report and audio/video recordings in a manner that is consistent with applicable law, APA Standards, best practices, and agency policies. Where differences exist, local statutes applicable to the polygraph will prevail.

2.3 Examiners should retain all examination materials and make all materials available for quality assurance review, except where prohibited by agency policy or statute.

3. QUALITY ASSURANCE REVIEW

3.1 Reviewers should thoroughly review all examination materials including written examination reports, recorded test data and audio/video recordings.

3.2 All quality assurance reviews should be conducted under an agreement for confidentiality. Reviewers should remain aware that all examinations materials and copies are the property of the original examiner and should not be retained without permission.

3.3 Quality Assurance review, whether self-review, internal review, external review or blind review, should document the review process and conclusions in written form, including the following suggested items.

3.3.1 Requesting Parties:

3.3.2 Examinee (optional):

3.3.3 Date of Examination:

3.3.4 Original Examiner:

3.3.5 Type of Polygraph (Diagnostic / Screening)

3.3.6 Detailed list of materials for review
3.3.7 Review of the polygraph setting
3.3.8 Review of the pretest interview
3.3.9 Review of the question formulation
3.3.10 Review of the in-test data collection
3.3.11 Review of the test data analysis
3.3.12 Summary

3.4 A review of the pretest information to the examinee should include:

3.4.1 Examiner verified the identity of the examinee.

3.4.2 Examiner explains the instrumentation and process, including that the examination can be terminated at any time, and obtained the informed consent of the examinee.

3.4.3 The purpose of examination was explained.

3.4.4 The examination topics were adequately reviewed with the examinee.

3.4.5 Examination questions were fully reviewed with the examinee prior to beginning the in-test recording phase.

3.5 A review of the examiner conduct during the pretest should include:

3.5.1 Interview conducted in a non-accusatory manner.

3.5.2 Target issues are thoroughly reviewed to assure examinee’s understanding.

3.5.3 Relevant questions are descriptive of the issue under investigation, and not likely to cause confusion or uncertainty.

3.5.4 Development of comparison questions was consistent with the type of comparison question utilized.

3.5.5 All questions were discussed and reviewed prior to the administration of the test and were answerable with a yes or no or other instructed answer.
3.6  Collection of data and collection of charts should include:
   3.6.1 Examiner conducted an Acquaintance chart where applicable.
   3.6.2 Examiner utilized a validated test format.
   3.6.3 Recording sensors, including activity or movement sensor, are functioning properly.
   3.6.4 Proper question pacing is observed and questions are correctly marked with the start and stop location of each exact question that was asked along with the examinee’s answer.
   3.6.5 Effective placement and attachment of recording sensors is observed, facilitating adequate data collection.
   3.6.6 In-test chart annotations correctly indicate any instructions or other events occurring during the recording of each question series.
   3.6.7 Test stimuli questions are presented in a neutral manner.

3.7  A review of Test Data Analysis should include:
   3.7.1 Physiological data is of adequate quality for interpretation.
   3.7.2 Examiner used a validated method for test data analysis.
   3.7.3 Review examiners should avoid and or note any attempts to score unstable data, or data of artifacted or unusual quality.
   3.7.4 Reviewing examiners should analyze the data using a validated method for test data analysis, and should identify the analysis method for the examiner and the review. The source of any discrepancies with the analysis and conclusion of the examiner should be described.

4. REVIEWING EXAMINER’S REPORT
   4.1 Reviewers should be objective and factual in determining compliance and non-compliance with published standards of practice.
   4.2 Reviewers should avoid any discussion or inference about the exami-
iner’s competency, which cannot be done from the review of a single examination.

4.3 Reviewers should only report on issues of compliance with local statutes, APA Standards of Practice and other applicable guidelines.

4.4 Reviewers should not attempt to reverse the conclusion or offer a conclusion in opposition to that of the examiner unless a gross error is identified (original examiners have tended to be more accurate than blind review).

4.5 Reviewer opinions shall be expressed as:

4.5.1 Examination is supported.

4.5.2 Examination is not supported.

4.5.3 Review cannot be completed without additional information.
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...it isn't the instrument... it's the examiner
Chuck Michaels
By George Baranowski

It’s obvious that we live in a pretty remarkable time. We have an infinite wealth of information, connections and resources at our fingertips, well I guess mostly one fingertip, or maybe a thumb, when you think about it, thanks to the internet and smartphones. But what I’ve just figured out is that we don’t have an abundance of time, which comes out like kind of a scarce resource. I’ve come to the conclusion that they are valuable to me, and also its really valuable to marketers and social media platforms.

It’s kind of interesting how I came to this conclusion. I left my phone at the office one day, and when I realized this at home, I couldn’t believe the annoyance I experienced because I wasn’t able to find out what was going on “right now.” I started to realize however (after I got my phone back) that there wasn’t anything on that phone that I really needed to access or respond to. I came to the realization that when you start treating your attention as your most valuable resource, you’ll protect it more. I think you have to admit that learning how to budget your attention is a really important skill, probably an essential one, given the world we live in.

Your phone, the apps you use and every website you visit is designed to
capture your attention. Media companies write scary headlines on purpose. Just say something like “Donald Trump is going to do this, or did that…” and see what happens. Everyone says they want more positive news, but we know from decades of history, that we all pay more attention when there’s controversy, big time uncertainty or tragedy.

Media companies know this, and use it to their advantage. They know this kind of stuff will get your attention. Headlines that trigger feelings of uncertainty “Make you look”. That’s why the news media writes those things that way. And when they have your attention, they make money. And guess what you lose? Your time, your dreams, maybe even part of your well-being.

Consider the real reason we check our phones up to 150 times a day on the average: It’s like you might find that important message, that important event, or some kind of reward you don’t want to miss. It also explains why people keep pulling a slot machine lever over and over. Because every once in a while, when you look again, you might get a winner (or a good email) so we keep checking in case there’s a random surprise waiting for you there.

I remember someone saying years ago that if you want the best of everything in life, the skill of eliminating what you don’t want is the road to follow. You might start by asking a simple question. Do I use my phone as a tool to advance myself, like reaching my goals, making money, or is my phone using me?

Personally, I have completely avoided ever getting involved in Facebook. I see this as mindlessly scrolling through Facebook News Feed to see things such as someone letting the world know that their daughter has
become potty trained, or their dog has puppies. I realize that this social exchange does make some people feel good, but in a sense, it’s good to remind yourself that you are the product and your attention is being sold.

And it goes beyond social media platforms. Every moment of every day there is something begging for your attention: emails to reply to, texts to send, phone calls to answer, pop-up ads to sit through.

What I’ve thought about doing to make my attention more valuable is to protect like the first hour of my day. When I wake up, I don’t look at the phone. I don’t log on to my computer. I don’t give these devices my attention. (Well, I admit, I try not to give these wonderful devices my attention). Yeah, I know that I probably shouldn’t turn on the TV either, but this calling to see what happened last night that I need to know about, or what Trump did now (or didn’t do, or may do, or might be thinking of doing), is far too much a challenge to me to eliminate completely. Okay, I admit that this habit of watching morning TV does have some of that control I’ve been talking about. And yeah, I admit this contradicts what I’ve been trying to say here, but hey, I’m just human also, right? Does that work?

In reality, in today’s world, our attention is being bought and sold all day long and sure, it’s probably making some companies some money. I feel that the way to look at this is it’s time to guard our most precious resource as best we can. What do you think?
“Price is what you pay. Value is what you get.”

- Warren Buffet
Practical Polygraph: Understanding and Managing the Vasomotor Photoelectric Plethysmograph

by Mark Handler\textsuperscript{1,2} and Raymond Nelson\textsuperscript{3}

The term “plethysmograph” is derived from the Greek term “plethymos” which means “an enlargement” or “fullness” and so the plethysmograph is a device for measuring and recording such changes. Examples of plethysmographs could include both the cardio cuff sensor and respiration sensors – because both of these respond to changes in circumference pressure. More often when referring to the plethysmograph, polygraph

\textsuperscript{1} Mark Handler is a former police polygraph examiner who teaches regularly at polygraph training programs, and is employed by Converus, Inc., a company that markets credibility assessment technology. Mr. Handler currently serves as the editor-in-chief for the APA. Mr. Handler is one of the developers of the OSS-3 and ESS models for the analysis of polygraph test data and has published numerous papers on many aspects of the polygraph test.

\textsuperscript{2} There are no financial or proprietary interests associated with this publication. The views and opinions expressed herein are those of the authors, and not necessarily those of LIC, APA, or Converus Inc.

\textsuperscript{3} Raymond Nelson is a psychotherapist and polygraph examiner who works as a polygraph research specialist for Lafayette Instrument Company (LIC). Mr. Nelson is a past-president and currently serves as an elected member of the Board of Directors for the APA. Mr. Nelson is one of the developers of the OSS-3 and ESS models for the analysis of polygraph test data and has published numerous papers on many aspects of the polygraph test.
examiners are referring to a vasomotor sensor, in the form of a photoelectric plethysmograph (PLE). The PLE is used to record relative changes in pulse-wave blood-pulse volume in the tiny capillaries in the skin of the fingertips. This is what we are interested in for polygraph purposes – fingertip pulse volume or vasomotor activity. The PLE sensor allows us to record and extract information about relative changes in blood-pulse volume in the body segment where the sensor is attached. Fingertip blood-pulse volume, or vasomotor activity, can be measured as the distance between diastolic and systolic peaks in the PLE pulse waveform. Evaluation of the PLE data is a matter of observing and comparing the diagnostic changes in the PLE data in response to different test stimuli.

Wherezitgo? (where to attach the PLE sensor)

The PLE sensor can be attached to any of the digits of the left or right hand. All that is necessary is that the sensor can be easily positioned and that usable data is easily obtained. We recommend placing the PLE on the middle finger or the thumb to start as these have the larger arterioles compared to other fingertips. Try a different fingertip location if the tracing is not easily adjustable to 2-4 chart divisions.

Howzitwork? (tech stuff)

The photoelectric plethysmograph (PPG) uses a light source and a photosensitive cell to measure changes in light that is reflected or passed through the tissue segment where the sensor is placed. The light produced by the source is in the infrared range (7000 to 9500 Angstroms or 700 to 950 nanometers). Light waves in the infrared frequency ranges are scattered or reflected by red blood cells – which is why these cells appear red to our eyes – and the amount of light that reaches the photo-sensitive sensor.

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4 Plethysmograph sensors are also when testing sexual arousal, using a sensor designed to record small changes in penile tumescence that occur in response to test stimuli. An acronym for the penile plethysmograph is PPG, and for this reason we will use the acronym PLE in this document – mainly to avoid any potential confusion about the location of the sensor placement on the examinee during polygraph testing. In the medical field, the photoelectric plethysmograph is referred to as a PPG. The PLE sensor should be attached only to the fingertips during polygraph testing.

5 Other uses of the photoelectric sensor include monitoring pulse rate and respiration rate in medical settings.


7 One angstrom = one hundred-millionth of a centimeter, or 10–10 meter. Angstroms are used to express wavelengths and interatomic distances.

8 One nanometer (nm) = one billionth of a meter, such that 7000 angstroms = 700 nanometers.
cell is related to the amount of blood through which it passes before reaching the sensor.

The photo sensor can be placed on the same skin surface as the light source, in which case we are observing changes in the amount of light that is reflected back is measured. Alternatively, the photo sensor may be placed on a skin surface opposite from the light source in which case we would observe changes in the amount of light that is transmitted through the tissues to the photo the sensor. Figure 1 shows the amount of light making it to the sensor depends on how much light is absorbed or scattered. How much of the light that makes it to the sensor depends on how much is lost as a function of the distance the light has to travel to reach the sensor and on the concentration of light absorbing material.

**Figure 1.** Illustration of light waves in the PLE sensor. (Reprinted and used with permission from How Equipment Works.com.) http://www.howequipmentworks.com/physics/respi_measurements/oxygen/oximeter/pulse_oximeter.html

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**Whyzitwork? (Physiology)**

Arteries and smaller arterioles carry oxygenated blood away from the heart to serve the body tissues. Arteries are large vessels that consist of mostly of collagen and elastin fibers along with a smaller amount of smooth muscle.<ref>Blood vessels branch off and become progressively smaller as blood travels further from the heart, and the smaller diameter vessels in the periphery have a higher concentration of smooth muscle than the larger diameter vessels closer to the heart. Small arteries called arterioles play an important part**
in managing systemic blood pressure. The arterioles maintain their diameter based on the amount of sympathetic innervation they are receiving at any given time. They receive a constant sympathetic innervation that is sometimes referred to as vasomotor tone.

Because innervation causes muscles (including smooth muscle) to contract, vasodilatation is achieved by a reduction in sympathetic innervation. Conversely, vasoconstriction results from sympathetic nervous system activation of the smooth muscles in the arterioles. It is for these reasons that vasoconstriction or vasomotor activity can be exploited as a proxy for increases in activity in the sympathetic division of the autonomic nervous system.

Hemoglobin (Hb) in our blood absorbs light and the amount of light absorbed is proportional to the concentration of Hb in the blood vessel. Other substances also absorb light, but those substances are consistent during polygraph testing. The major source of variation in light absorption during polygraph testing is the amount of blood and Hb present in the tiny vessels in the skin, and these changes are known to be related to increases and decreases in sympathetic innervation. As the vessels constrict, there is less blood present, so there is less hemoglobin to absorb the light.

In Figure 3, one blood vessel has a low Hb concentration and the other blood vessel has a high Hb concentration. Each single Hb absorbs some of the light, so more light is absorbed when there is more Hb per unit area. By measuring how much light reaches the light detector, the PLE sensor can be used to calculate how much light has been absorbed. When there is more Hb in the finger, more of the light is absorbed and less light reaches the photo sensor. Changes in the local volume of Hb at the PLE sensor site are a function of vasoconstriction.
which is a function of sympathetic innervation. See figures 2 and 3.

**Figure 2.** Two examples of hemoglobin concentration. (Reprinted and used with permission from How Equipment Works.com.)

![Diagram of hemoglobin concentration with low and high concentration]

**Figure 3.** Varying Hb concentration as a function of vasoconstriction. (Reprinted and used with permission from How Equipment Works.com.)

![Diagram of varying Hb concentration with light path length and absorption]
Whatzitmean? (Feature extraction and scoring)

Because vasoconstriction is a function of sympathetic innervation, the feature of interest to polygraph examiners is the constriction or reduction of fingertip blood-pulse volume. A reduction of fingertip blood-pulse volume is an indication of sympathetic innervation, for which changes can be compared according to the analytic theory of the polygraph test\textsuperscript{12}. Vasoconstriction can be observed in the PLE data as a reduction of the distance between the diastolic and systolic peaks in the PLE waveform, when comparing the data after stimulus onset to the data prior to stimulus onset.

Figure 4 shows an acquaintance test with the PLE and other sensor data, along with visual guides to assist in the identification of the diagnostic information for feature extraction. Researchers have shown the optimal response period, between pre-stimulus and post-stimulus blood-pulse volume differences, to occur between 5 seconds and 10 seconds after stimulus onset. To more easily assist in the extraction and comparison of observed vasoconstrictions the vasomotor pulse amplitude is also shown for the 3-second period prior to stimulus onset. Reaction features in Figure 4 have been rank ordered, and it can be seen that the vasoconstriction at question 3K is a greater change in physiological activity compared to the other responses.

Although some information can be obtained from the PLE data using visual feature extraction alone, more diagnostic information can be obtained through the use of computer algorithms. Computers can be used to highlight the reaction feature and increase the reliability and precision of visual feature extraction. They can just as easily be used to fully automate the feature extraction process. The goals of a scientific test such as the polygraph test or other forensic test is to achieve a professional opinion that is supported by analysis of the test data. The practical goals are twofold:

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\textsuperscript{12} The analytic theory of the polygraph test holds that greater changes in physiological activity are loaded at different types of test stimuli as a function of deception or truth-telling in response to the relevant target stimuli. For more information refer to Nelson, R. (2016). Scientific (analytic) theory of polygraph testing. APA Magazine, 49(5), 69-82.

Figure 4. Acquaintance test with feature extraction for PLE and other sensors.

1) achieve a conclusion or classification, and 2) calculate and communicate a realistic estimate of the level of confidence or margin of uncertainty associated with that conclusion – the probability or likelihood or odds that a conclusion is correct or incorrect (or the likelihood that a conclusion was based on test data that occurred due to random chance). The addition of more data can help to achieve the first objective only as long as the additional data are valid and do not co-vary with other data to such a degree that it distorts or disrupts the stability and effectiveness of the analysis model.

Until recent years many field practitioners gave little thought or attention to the second objective – quantification of the probabilistic confidence and uncertainty associated with the test result. Traditional polygraph analysis methods – those developed prior to the use of computers – relied on cut scores that were selected either arbitrarily or heuristically, though without attention to the calculation of statistical confidence or uncertainty estimates for individual exams. Polygraph error estimation, at that time, was limited to the analysis of test performance with groups or samples of cases.

The trend in forensic science in recent decades has been towards the
increased use of computers and analysis models designed to compute statistical confidence and error estimates for individual cases in addition to the study of test precision and error rates for groups such as a population or research sample. Although statistical reference tables have been published for the array of polygraph techniques in use today\(^\text{14}\), most available reference tables do not include the PLE sensor. Computer algorithms may or may not make use of PLE data, and it should be the role of algorithm developers and vendors to provide information on this.

Inclusion of the PLE sensor data in manual analytic decision models, developed without the PLE, may have the potential to distort or overload the reference distributions or likelihood functions by adding information that is not accounted for in the statistical calculations. For example ESS tables and most other published reference data do not include the PLE sensor. Until such time as reference tables or likelihood functions become published and available it will be important to remain aware that the inclusion of the PLE sensor will mean that our calculations of the test error statistic – in the form of a p-value that can also be thought of as either the area under the normal distribution or the cumulative distribution function (i.e., the sum of all probabilities up to and including the test error statistic) – can be expected to be a biased estimate. This is acceptable only inasmuch as we expect the estimate to be biased towards the overestimation, and not the underestimation, of decision errors.

It will be important for researchers, developers and technology vendors to continue to advance the state of polygraph science. At such time published knowledge and information are able to mathematically and statistically account for the added PLE data, continued use of reference table and likelihood functions developed without the PLE data will become more scientifically and ethically questionable.

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Questions of Legal Regulation and Practice of Polygraph Application in Ukraine

Current aspects of legislative basis for using polygraph in Ukraine are analyzed. Practical issues related to qualified training of Ukrainian polygraph examiners, as well as to the activities of public organizations which coordinate and implement methodical processes of applying polygraph in Ukraine are considered.

Key words: polygraph, polygraph examiner, legal regulation, normative legal acts, polygraph practice, public organizations.

History of active polygraph use in Ukraine, in various fields, stretches back more than 20 years. In 1997 Ukrainian diaspora in the United States handed over ten "Axciton" devices supplied with software to Ministry of Internal Affairs (MIA) of Ukraine. The following year, the Ministry made the first attempts to use polygraph in the operative investigation work of Ukrainian law enforcement agencies. Lack of appropriate training and experience in the country forced the law enforcement agencies to seek help from foreign specialists. In 1998, a group of employees of law enforcement agencies attended courses for polygraph

1 Doctor of Law, professor, honored jurist of Ukraine, Ukrainian National Academy of Internal Affairs, Kiev, Ukraine
2 polygraph expert, psychologist, chairman of Ukrainian Polygraph Collegium, Kiev, Ukraine
examiners at Main department of Internal Affairs of the Krasnodar Territory (Russian Federation). In 1999, five officers from National Academy of Internal Affairs of Ukraine and Lviv Law Institute of MIA of Ukraine studied for two months at the Academy of Forensic Psychophysiology in Largo, Florida, US. After training, polygraph examiners of the National Academy of Internal Affairs of Ukraine repeatedly provided assistance to Ministry of Internal Affairs in carrying out expert psychophysiological studies of subjects suspected of committing crimes. These events served as a starting point for the development of schools, directions and methodology for polygraph use both in law enforcement agencies and in commercial structures.

Over the past 10 years polygraph in Ukraine has become increasingly popular in commercial structures, including banks, insurance companies, agricultural holdings, IT companies, large trading networks, other private and state-owned Ukrainian enterprises.

During polygraph implementation in Ukraine, number of various acts, ordinances and instructions was issued to regulate its application legally. Let us consider the main ones.

1) Order #1dsk of January 26, 2000 of the Main department for fighting organized crime of MIA introduces use of polygraph by human resources department and operative search units fighting organized crime.

2) MIA order No. 743 of August 28, 2001 [1] "On conducting an ex-
experiment on use of computer polygraphs by law enforcement agencies" introduces polygraph to law enforcement agencies of Ukraine lifting the restrictions on using the device in operative search. Later on its basis, the Concept for implementation of computer technologies using polygraph into system of the MIA of Ukraine was developed.

3) Act No. 743 of August 28, 2001 was followed by the next order in MIA system of "On further development of the Service of Psychological Support for operative activities of law enforcement agencies of Ukraine" No. 842 of July 28, 2004 [2], registered by Ministry of Justice of Ukraine on October 27, 2004, No. 1365/9964.

4) The above-mentioned ordinances were followed by "Instruction on procedure for using polygraphs (computerized devices for recording psychophysiological reactions of a person)" No. 1373/9972 [3], which greatly expanded possibilities of using polygraph in criminal proceedings in Ukraine. Later, decision of MIA Collegium of Ukraine of July 25, 2008, No. 17 km/1 "Programs for counteracting crimes against the person in 2008-2012" [4] was approved, where clause 4.23 provided for systematic use of polygraph and the results of its work by law enforcement agencies aimed at effective detection of crimes against life and health of the person. Unfortunately, this process stalled because of the political situation in our country.

5) It should also be noted that as of November 1, 2010 National Classifier of Ukraine DK 003: 2010 "Classifier of occupations", approved by order of State Consumer Committee No. 327 of July 20, 2010, came into effect. In this classifier, under the code 2144.2, a new occupa-
tion "Polygraph Expert" was introduced.

6) Another important departmental legal act is order No. 329 of Ministry of Incomes and Fees of Ukraine of August 2, 2013 "On using polygraphs in the activities of Ministry of Incomes and Fees of Ukraine and its territorial bodies" [5], registered by Ministry of Justice of Ukraine on October 11, No. 1748/24280. This order is aimed at improving efficiency of Ministry of Incomes and Fees, preventing and identifying corruption and other offenses, supporting operative activities effectively, as well as improving work with personnel. Based on this order, "Guidelines for using computer polygraphs in work of the Ministry" have been developed.

7) One more crucial order was issued by Ministry of Defense and Armed Forces of Ukraine "On approval of the Instruction on procedure for organizing and conducting polygraph survey of personnel in Ministry of Defense and Armed Forces of Ukraine" [6] No. 164 of April 14, 2015, aimed at improving quality of work with personnel during admission to (renewal of) contract military service, appointment (transfer) of officers by the Minister of Defense of Ukraine, appointment of Ukrainian citizens into civil service or to positions in departments of Ministry of Defense and General Staff of the Ukrainian Armed Forces; as well as at prevention and detection of corruption and other offenses. To accompany this order, instruction "On procedure for organizing and conducting polygraph survey of personnel in Ministry of Defense and Armed Forces of Ukraine" was developed; it was registered as No. 477/26922 by Ministry of Justice of Ukraine on April 29, 2015.

8) Polygraph was also mentioned in Law of Ukraine "On National Police" [7], which came into effect on November 7, 2015. In particular, Part 2 of Art. 50 of this Law defines constitutional requirements for the procedure of polygraph testing for citizens who have expressed a desire to enter service in National Police.

9) On July 27, 2015, Ministry of Justice of Ukraine issued Order No. 1350/5 "On introduction of amendments to the Order No. 53/5 of Ministry of Justice of Ukraine of October 8, 1998" [8], which modified methodological recommendations on preparation and appointment of forensic examinations and expert studies. By this order Ministry of Justice supplemented Section VI "Psychological Expertise" with a new paragraph 6.8: "In order to obtain
tentative information, surveys can be conducted using special technical means – computer polygraph." That is, results obtained using polygraph can be officially used in criminal, civil, administrative, economic and other proceedings, or on request of interested individuals (or legal entities). In connection with the above-mentioned order, number of psychological examinations with the use of polygraph performed both by state and private experts, increased significantly.

10) Initiative group of Ukrainian Polygraph Collegium together with scientists from National Academy of Internal Affairs, MIA of Ukraine developed draft of the Law of Ukraine No. 4094 "On protection of rights of the individuals undergoing polygraph survey (examination)" and submitted it to the Parliament of Ukraine. The main goal of this act was to regulate use of polygraph in the country. Unfortunately, this legal act did not find proper support during discussions in the Parliament Committees and other relevant expert institutions and was rejected with the possibility of revision.

11) In connection with the adoption of law No.794-VIII "On State Bureau of Investigation" of November 12, 2015, Cabinet of Ministers of Ukraine entrusted Ministry of Health to create an interdepartmental working group to develop procedure for organizing and conducting a survey of individuals using polygraph at State Bureau of Investigation. (Order of Ministry of Health of Ukraine № 3.12.-10/12/320-16/ 8288 of April
4, 2016). This group included representatives from Ukrainian Polygraph Collegium. As a result, in the spring of this year Cabinet of Ministers of Ukraine approved procedure developed by the interdepartmental working group.

According to this document, a polygraph study is conducted to obtain tentative information about candidates as to: concealment or distortion of personal data, certain facts of the biography; alcohol or drug abuse; presence of debts or financial obligations. Other topics the procedure also provides for checking on a polygraph are: violations of the law, prior criminal proceedings, involvement in criminal organizations, participation in prohibited public associations, residence permit or citizenship of another country, disclosure of confidential information.

As for the practical side of polygraph use in Ukraine, the following should be noted:

1) Due to fundamental changes in the political life of Ukrainian society, aggravation of political and economic relations with the Russian Federation, anti-terrorist operation in the Donbass, fight against corruption and many other internal and external social processes, use of polygraph in various state institutions and law enforcement agencies is gaining momentum. There is significant increase in number of polygraph examiners in departments of Ministry of Internal Affairs, Security Service of Ukraine (SSU), polygraph examiners also appeared in Ministry of Defense, National Anti-Corruption Bureau, State Border Guard Service of Ukraine, etc.

2) Obviously, increased demand for specialists in polygraph application area raised the issue of qualified training of the personnel. In Ukraine today, the only educational license for training specialists in polygraph testing is available at Academy of SSU, and its primary goal is to meet the needs of operative services of this agency. Still there are private training courses for polygraph testing in our country. Representatives of these courses or schools, as they are called, are committed to different methodological approaches.

3) It should be noted that many polygraph examiners currently working in law enforcement agencies were trained by different private schools. Therefore, there can be significant differences in methodological arsenal and conceptual apparatus used, which inevitably leads to various collisions between polygraph specialists themselves
and customers of their services.

4) Such situation partly caused creation of public organizations of polygraph examiners aimed at uniting specialists in the area and developing uniform standards of practice. Yet disagreements of professional nature remained. At the moment, there are two active public organizations in Ukraine: All-Ukrainian Polygraph Association and Ukrainian Polygraph Collegium.

- All-Ukrainian Polygraph Association was registered on November 21, 2014 and for the most part consists of polygraph examiners, who were trained according to original techniques of Ukrainian specialists, as well as on the basis of methodical approach of Russian scientist Valery Varlamov.

- Ukrainian Polygraph Collegium is the first established in Ukraine public organization in the area, which has been operating since October 7, 2013 to the present day. It brings together civilian (private) polygraph examiners from commercial companies, banks and polygraph experts from various domestic military and law enforcement agencies, such as Kiev research institute of forensic examinations, Ministry of Defense, State Fiscal Service, Ministry of Internal Affairs, National Police, National Guard, National Academy of Internal Affairs of MIA of Ukraine and other.

When conducting polygraph tests, members of Ukrainian Polygraph Collegium follow practice standards of the American Polygraph Association (APA) and use valid, scientifically validated testing techniques, which, according to the results of meta-analysis carried out by special APA committee, were recommended as main techniques for conducting polygraph tests.

Since 2013 Ukrainian Polygraph Collegium regularly holds international scientific-practical conferences and seminars devoted to current issues of
polygraph application. Polygraph examiners and scientists from USA, Canada, Poland, Slovenia, Azerbaijan, Kazakhstan, Belarus and other countries were invited to participate in these events. Members of the Collegium regularly attend professional development courses, among them seminars of Chuck Slabsky, Nate Gordon, Greg Adams, Donald Krapohl, and 50th Annual APA seminar in Chicago.

Over the past few years, members of the Collegium have prepared number of scientific publications, books, monographs devoted to polygraph and assessment of information reliability, also two issues of "Current problems of theory and practice of using polygraph", journal established by Coordinating Council of the Collegium, were published.

As we have shown, practice of using polygraph is actively developing in Ukraine both in legislative and scientific area. Authors of this article hope that cooperation and fair competition between public professional organizations, polygraph specialists at state agencies, commercial companies specializing in polygraph tests, will help methodological development and pledge compliance with high ethical and professional standards.
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Understanding and Scoring the PLE

by Bruce White

Scoring the PLE requires an understanding of the 4 waveform elements present in a PLE

1-Vascular constriction. As emotional stress increases, a short term vertical amplitude constriction occurs, followed by a recovery expansion. The duration is typically about 10 seconds from stimulus.

2-Waveform quality. A high quality PLE will typically have a vascular pulse height that does not change erratically in amplitude or shape from those pulses before and after it. A lower quality PLE looks ‘Raggedy’ with rapid beat to beat changes in amplitude and shape. Low quality PLE’s should not be scored. A low quality PLE will have a high standard deviation in its pulse calculation.

3-Long, low frequency, tonic trends in the vascular pulse height.

4-Underlying repetitive patterns, such as ‘vagas roll’ from breathing, which may overlay the PLE waveform.

Please view the following set of math traces for reference to the descriptive math that follows.
-The **BROWN** trace is a well behaved PLE trace

-Above the BROWN PLE trace is the same PLE trace but with a 1 hertz, first order, high pass filter (to reduce baseline variability), this is just used here for visual reference.

-At the bottom of the screen is the systolic only component of the raw PLE placed on a flat baseline, and is labeled PSYS on the right side of the screen.

-Shortly above this systolic filter of the PLE is its inverted trace titled -PSYS.

-At the bottom edge of the inverted systolic filtered PLE is a thick curve fitting line that follows the contour of the bottom of this trace. This curve fitting line is called the GSR style PLE. As this trace line moves upward a subject’s stress increases, and as it relaxes the stress is lessened. This approach allows the GSR style PLE to be scored exactly like a standard GSR. (Compare the big bumps to the small bumps) thereby eliminating the need for examiner retraining on scoring methodology.
The math to achieve this GSR style PLE is as follows

**GSR Style Plethysmo Filter**

For a 250 Hz sample rate:

<table>
<thead>
<tr>
<th>Low pass 10 Hz, 1st order</th>
<th>State for low pass filter</th>
<th>( v_L(n) = x(n) + 0.778 \cdot v_L(n - 1) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low pass filter</td>
<td></td>
<td>( y_L(n) = v_L(n) + v_L(n - 1) )</td>
</tr>
<tr>
<td>Systolic filter</td>
<td></td>
<td>( \nabla y_L(n) = y_L(n) - y_L(n - 1) )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \sum_{i=0}^{\nabla y_L(n-\cdot i)&gt;0} y_L(n - i) )</td>
</tr>
<tr>
<td>Zero phase low pass 0.1 Hz, 4th order</td>
<td>Low pass filter state, reverse</td>
<td>( v_{LR}(n) = x(n) - 1.996 \cdot v_{LR}(n + 1) + 0.996 \cdot v_{LR}(n + 2) )</td>
</tr>
<tr>
<td></td>
<td>Low pass filter, reverse</td>
<td>( y_{LR}(n) = v_{LR}(n) + 2 \cdot v_{LR}(n + 1) + v_{LR}(n + 2) )</td>
</tr>
<tr>
<td></td>
<td>Low pass filter state, forward</td>
<td>( v_{LF}(n) = y_{LR}(n) - 1.996 \cdot v_{LF}(n - 1) + 0.996 \cdot v_{LF}(n - 2) )</td>
</tr>
<tr>
<td></td>
<td>Low pass filter, forward</td>
<td>( y_{LF}(n) = v_{LF}(n) + 2 \cdot v_{LF}(n - 1) + v_{LF}(n - 2) )</td>
</tr>
<tr>
<td></td>
<td>GSR style Plethysmo filter</td>
<td>( y(n) = y_{LF}(-y_s(-y_s(n))) )</td>
</tr>
</tbody>
</table>

The above math works very well on PLE’s with a good signal quality. The challenge is to know when The PLE should not be scored due to poor signal quality (#2 see above)

My research so far shows that the most practical way to grade a PLE’s signal quality, is to calculate the beat to beat pulse of the PLE, and then calculate the standard deviation of the beat to beat pulse, and then to set a threshold below which the scoring is set to a fixed value of ‘0’ i.e. not scored.

The math to achieve this PLE signal quality measurement via the pulse calculation formula and its beat to beat standard deviation is as following.
Pulse Rate Standard Deviation

For a 250 HZ sample rate:

<table>
<thead>
<tr>
<th>Band pass 0.107 to 14.5 Hz, 4th order</th>
<th>State 1: ( v_1(n) = x(n) + 1.65 \cdot v_1(n-1) - 0.763 \cdot v_1(n-2) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band pass filter 1: ( y_1(n) = v_1(n) + 2 \cdot v_1(n-1) + v_1(n-2) )</td>
<td></td>
</tr>
<tr>
<td>State 2: ( v_2(n) = y_1(n) + 1.41 \cdot v_2(n-1) - 0.510 \cdot v_2(n-2) )</td>
<td></td>
</tr>
<tr>
<td>Band pass filter 2: ( y_2(n) = v_2(n) + 2 \cdot v_2(n-1) + v_2(n-2) )</td>
<td></td>
</tr>
<tr>
<td>State 3: ( v_3(n) = y_2(n) + 1.998 \cdot v_3(n-1) - 0.998 \cdot v_3(n-2) )</td>
<td></td>
</tr>
<tr>
<td>Band pass filter 3: ( y_3(n) = v_3(n) - 2 \cdot v_3(n-1) + v_3(n-2) )</td>
<td></td>
</tr>
<tr>
<td>State 4: ( v_4(n) = y_3(n) + 1.996 \cdot v_4(n-1) - 0.995 \cdot v_4(n-2) )</td>
<td></td>
</tr>
<tr>
<td>Band pass filter 4: ( y_4(n) = v_4(n) - 2 \cdot v_4(n-1) + v_4(n-2) )</td>
<td></td>
</tr>
<tr>
<td>Derivative ( \Psi(n) = x(n) \cdot x(n-1) )</td>
<td></td>
</tr>
<tr>
<td>Median, 5 samples ( \text{med}_5(n) = \text{median}(x(n), x(n-1), x(n-2), x(n-3), x(n-4)) )</td>
<td></td>
</tr>
<tr>
<td>Positive only ( p(x) = \begin{cases} 0 &amp; x \leq 0 \ x &amp; x &gt; 0 \end{cases} )</td>
<td></td>
</tr>
<tr>
<td>Median, 3 samples ( \text{med}_3(n) = \text{median}(x(n), x(n-1), x(n-2)) )</td>
<td></td>
</tr>
<tr>
<td>Threshold max ( t_{\text{max}}(x, t) = \begin{cases} 0 &amp; x &gt; t \ x &amp; x \leq t \end{cases} )</td>
<td></td>
</tr>
<tr>
<td>Threshold min ( t_{\text{min}}(x, t) = \begin{cases} 0 &amp; x &lt; t \ x &amp; x \geq t \end{cases} )</td>
<td></td>
</tr>
<tr>
<td>Threshold ( t(n) = \max \left( \sum_{j=0}^{n} 5 \cdot \frac{x(j)}{n}, 48 \right) )</td>
<td></td>
</tr>
<tr>
<td>Pulse rate filter ( p_T(x) = t_{\text{min}}(t_{\text{max}}(p(\text{med}_3(V(\text{med}_5(V(y_4(n))))))), 25000), t(x)) )</td>
<td></td>
</tr>
</tbody>
</table>

Pulse rate variance

The pulse rate filter generates a signal with a single zero to non-zero transition for each pulse beat. The standard deviation of the times between these transitions is then calculated using the following equations.

\[
\bar{f}(n) = \frac{\sum_{i=1}^{n} f(n) - \bar{f}(n-1)}{n}
\]

\[
s(n) = \sum_{i=1}^{n} (f(n) - \bar{f}(n-1)) \cdot (f(n) - \bar{f}(n))
\]

\[
\sigma(n) = \sqrt{\frac{s(n)}{n}}
\]
The end result of this math processing is that **the two traces below** represent the same data.

![Raw PLE vs GSR style PLE](image)

So far this approach appears quite robust, and has the added benefit that a polygraph examiner has a choice to either rely on our automated PLE score, or his own hand PLE score using standard GSR rules where upward movement of the PLE indicates stress just as it does in the GSR. In polygraph slang terms ‘compare the big bumps to the smaller bumps’.

Below is the **final** full chart appearance, **ready for scoring** (PLE pulse standard deviation here is <0.2):
Example of a truthful chart from (PLE pulse standard deviation <0.2):

![Chap.png](image-url)
Waveform Quality

The following is an example of a low quality PLE that should not be scored (This PLE has a pulse standard deviation of 0.81) exceeding the quality cut point of 0.22 we have set for now. So this PLE would not be deemed suitable for scoring.
PLE Tonic Change

PLE Good Candidate Indicators and PLE Practices

There appear to be several indicators if a polygraph subject will tend to produce a good or poor PLE quality trace.

-First, if a polygraph subjects fingers are thin, boney, and not fleshy, this subject type appears to produce less productive PLE’s than a more fleshy hand.

-If a polygraph subjects hand is pinkish and ‘rosy’ on their palm rather than pale, it is a good sign of a well vascularized hand that could produce a productive PLE.

-A better PLE signal is likely to be produced if your PLE sensor is not overly tight and constrictive on the subject’s finger.

-The PLE sensor is best if placed on the hand opposite the constrictive blood pressure cuff.

-In general, the fleshy outer digit of a subjects thumb is the most productive PLE finger digit.

Summary:

Using this GSR style PLE for scoring is a superior way in both ease of use and accuracy for scoring the PLE compared to other scoring method choices.

Further, when the PLE quality is high, it is comparable to the GSR in the weight to be given to a chart score, and I would recommend that this
channel (the GSR style PLE) be included by examiners in their scoring to produce their most accurate results as a professional examiner.

This paper is a simplified summary of my PLE research. For a more complete discussion of the PLE, or other unpublished research, feel free to call the author at 713-789-8245 or 832-687-0630

Part 2 of this paper is for polygraph researchers only

Understanding the Frequency Energy distribution of the PLE across different frequency bands, with an objective of identifying low signal to noise bands for elimination.

The following PLE is a high quality PLE with a ple pulse beat to beat standard deviation of 0.05

Notice how the PLE frequency energy, and signal quality diminishes at frequencies above 7 or 8 hertz for a high quality PLE

A typical cardio upper arm pressure wave will have useful waveform energy up to 14 hertz. As a heartbeat waveform travels down to the finger tip of a subject, and passes through increasingly small channels down to a subject’s capillary bed, the cardio waveform preferentially loses its higher frequencies. What is interesting is that this appears to vary between subjects for their PLE. Some quality subjects have useful PLE energy up to 9 hertz, while other subject’s vascular systems produce PLE waveforms that are notably poor above 3 hertz. In general, a good band-pass for the PLE is from 0.5 hertz to 8 hertz for easy subjects, and 1 hertz to 4 hertz for low quality PLE waveforms. Empirically, my impression is that low quality PLE waveforms are best to not try to salvage. Researchers should take care to use zero phase frequency filters to avoid harmful time shifting that could affect scoring windows, also it is very desirable to have a reasonably fast frequency roll off, such as a fourth order roll off, as selected here. Also, a cautionary note to researchers, if you see your heart waveform shape become inverted from its raw input, you need to reconsider the math of your frequency filter.
Next is an example of a poor quality PLE with a PLE beat to beat pulse that has a standard deviation of 0.41 (we have chosen a cutoff of about .22 for minimal quality). Notice how the clarity of even the systolic rise becomes of little value past 3 hertz on a PLE with a pulse having a high standard deviation.
I have examples of some PLE’s whose pulse waveform shape transitions into an inverted waveform within 30 seconds or so, that are not well understood at the present. That is one of our areas of research interest. My present working hypothesis is that the PLE is a blend of absorptive and reflective infrared ray-paths, and that they are inverted versions of each other. And that unknown physiological processes may deplete vascular flow on the skin's surface causing a dominance of reflective ray-paths. This is infrequent, but an interesting curiosity.

This PLE waveform shape reversal during its transition distorts the systolic height and direction, it could affect a PLE vascular constriction score when it occurs. This reversal is difficult for me to reproduce myself, but some examiner discussions indicate that it may be related to the PLE sensor hand being in the subjects lap or the sensor being attached too tightly around the finger. Interestingly, reversals, once they have occurred, will usually continue through the rest of the chart or session, and not return to its normal shape.
PLE Vagus is Unrelated to the Blood Pressure Vagus

Again, this is only a summary of part of our PLE research. If you are interested or have questions, call me at 713-789-8245 or 832-687-0630

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Five-minute Science Lesson: Bayesian and Frequentist Statistics – What’s the Deal?

by Raymond Nelson

Statistics is the mathematical language of science. Science is the process of attempting to understand reality: how the universe works. It’s a big universe, and so science tends to take things one little piece at a time, and then tries to put the pieces together. This is done with the expectation that if our knowledge about the little pieces of reality is correct then those little pieces should fit together harmoniously to explain more and more of the big universe. Still, it’s a big universe and so we will most likely never know everything. As a result, science is a process of continuous learning – always adding new knowledge and information to old. Making any practical use of new knowledge requires a bit of humility – we are forced to admit that our human knowledge is at best incomplete and is possibly incorrect in some ways.

In order for us to regard our incomplete/incorrect human knowledge as trustworthy the principles of science require that the experiments we use to learn, acquire knowledge, and make conclusions must be reproducible. To accomplish that we often need to move beyond subjective observation, and to do this we have learned to ask scientific questions that can be answered objectively. Yes or no? Where? How much? Which is greater? Which is smaller? Or, what is the order? These questions often require the application of numerical quantification, mathematical analysis and logic to our
data. As it happened historically, just about as soon as scientific thinkers and mathematicians began to record and calculate data with greater precision – following the renaissance, the introduction of algebra, calculus and geometry, and the first industrial revolution – they to notice unexpected variation when they compared reality to their expectations based on those precise calculations.

**Frequentist statistics is the quantification of measurement error**

The field of statistics originated out of a need to understand errors of measurement: measurement error. Today we have more generalized understanding of the concept of measurement error and random variation. But two-hundred and fifty years ago the great minds were still wondering this: why, with years of recorded information and precise observations and precise calculations from the best mathematical minds in history, did they observe that the planets were not exactly where their measurements and calculations suggested they would be? Is the universe fundamentally unstable? Is it all going to end in tragedy and chaos? These must have seemed like daunting and impossible questions to contend with. A more practical version of these questions is this: why is there variation in our measurement of the location of these things?

As it turns out, sometimes we have to quantify both the thing we want to quantify and the amount of variation in our data and calculations. The development of the principles of frequentist statistics allowed us to quantify observed variation in the data that is explained by factors that can be controlled or explained and the amount of variation that is uncontrolled or unexplained. In practical terms, frequentist inference allows us to better understand the location of the planets and other objects in the solar system. In broader terms it allows us to better understand the universe.

Today, frequentist inference is still very useful in all areas of science. For example: we may wish to learn about a population when it is not realistic to evaluate every member of the population. In this way, statistics is also about using knowledge from samples or small groups to make inferences about the population from which the sample was obtained.

These same principles can be used to make inferences at the level of the individual case. When this is done we have a scientific test as opposed to a scientific experiment. As a practical,
consider this: if in reality there are any physiological activities that are correlated with the difference between deception and truth-telling, then perhaps we can use the principles of frequentist inference, along with some knowledge about observed data from deceptive and truthful groups, to understand the explained and unexplained variation in the individual case data. In this way we can calculate the statistical likelihood that the data for a new and unknown case was produced by a member of the population represented by the deceptive or truthful group. Of course if all physiology is mere random chaos with absolutely no correlation between any changes physiological activity and deception or truth-telling, then the premise of scientific credibility assessment and lie detection will achieve results that are no different than could be achieved by random chance alone.

Frequentist inference is based on the frequency of occurrence of things that can be observed. Frequentist inference is premised on the notion that reality and the universe exist in one way – reality is fixed. When we want to make a conclusion about something that cannot be easily observed, we use the principles of statistical inference to calculate the statistical likelihood of observing the obtained data if reality does not exist in the way we think it exists. Because it regards reality as fixed (i.e., the universe exists only one way) frequentist inference is concerned not with the probability associated with the universe, but with the probability of obtaining the observed data if our knowledge or conclusions about reality and the universe are correct.

In frequentist inference, because reality is constant, data are variable. A different set of data is expected to give slightly different information about the universe. Frequentist inference is concerned with the statistical variation in the data as an approximation of reality. But the universe is still regarded as existing only one way. For example: a person either is or is not pregnant.

Bayesian inference is the calculation of causes for the observed data or evidence

Bayesian inference – named for Thomas Bayes who together with Pierre Simon Laplace laid the foundation for area of statistical knowledge – was first conceived of as a means of calculating the most likely cause of our observations about reality and the universe. There is an old adage in science and statistics: “correlation is not causation,” and Bayesian analysis is
intended to help us to move beyond this apparent impasse and quantify the most likely cause for our observed data. When we have some data or evidence from our observation of reality and the universe, Bayesian analysis allows us to calculate the most likely cause for that evidence.

Bayesian analysis treats virtually everything as a probability – including reality and the universe. This does not necessarily mean that Bayesian inference actually regards reality as variable – it means only that when reality is unknown there is some probability or likelihood associated with different ways that the universe exists in reality. Returning to the previous example: a person is still either pregnant or not pregnant, not both, and not partially one or the other. For another example, consider the situation of deception or truth-telling: truth and deception are, in reality, a deep and complex philosophical and epistemological rabbit hole that are beyond the scope of this paper, but for practical purposes we can consider that a person’s statements about a thing or event to be either truthful or deceptive, not both, and for practical purposes not partially one or the other.

Of course, when we can make perfect deterministic observations and conclusions then we have no need for Bayesian or frequentist statistics. Similarly, when we can make direct physical measurements we have no need for statistical estimation. The difference between Bayesian inference and frequentist inference is that when reality is unknown the Bayesian approach is to simply treat the unknown as a probability. The purpose of Bayesian inference is to help us make the best decision when our knowledge is uncertain. What is the probability that a person is pregnant or not pregnant? Or what is the probability that a person is deceptive or truthful? Whereas frequentist inference treats reality as fixed and data as variable, the Bayesian inference treats unknown reality as a probability.

Bayesian analysis says simply that when reality is unknown we think of the different possibilities. In practice it is seldom the case that we have absolutely no information about reality. More often we have some uncertain or incomplete knowledge or belief about the situation or phenomena of interest to us. Bayesian inference requires us to declare our knowledge or beliefs in the form of an a priori or prior probability, and then uses the observed data and evidence to mathematically update or modify our prior probability into a posterior probability. Posterior
probabilities have obvious practical value, but it is important to remember that we can have a posterior probability only when we are willing to declare or prior knowledge in the form of a prior probability (actually a prior probability distribution).

Another difference between Bayesian inference and frequentist inference is that Bayesian inference treats the available or observed data as fixed. The available data is all the information we have to use to modify our knowledge and conclusions about what we think we know about reality and the universe when our knowledge is uncertain. When we obtain more data we can again modify or update our knowledge and conclusions. But unless we achieve some perfect deterministic observation, or unless we achieve a direct physical measurement, our knowledge and conclusions about reality exist only as a probability that the observed evidence was caused by reality as our conclusions would have us think of it.

Because it goes more directly to conclusions about causes, Bayesian inference has tremendous practical application. It has been used to improve the accuracy of artillery trajectories, locate submarines, find lost or missing persons, and even to estimate the number of German tanks and crack the encryption codes of the enigma system during WWII. It is used routinely in medicine, epidemiology, finance, econometrics, data and business analytics, forensics, internet search engines, word prediction apps on mobile devices, sports statistics and sports betting, and, perhaps most importantly - filtering out email-spam for male-enhancement products or long-lost wealthy relatives in far away countries. Virtually every form of classification and prediction scheme in use today has made use of Bayesian inference in some way.

**Summary**

Science is a systematic way of thinking and acting to acquire and make use of new knowledge about reality and the universe. One difference between scientific knowledge and pseudoscience is that science is expected to keep learning and to keep making use of new knowledge, and any reasonably intelligent and diligent person can attain knowledge. In contrast, pseudoscience tends to rely on dogma that is sometimes static, with nothing new to learn about reality because it is not actually connected to reality, and sometimes accepted only from one source – the owner/originator/guru who can be the only true fountain of esoteric
wisdom. While science is about knowledge and reality and tends to diversify, pseudoscience is primarily about economics and power and tends to centralize.

Another difference between science and pseudoscience is that science expects us to quantify our knowledge even when it is difficult to do so, whereas pseudoscientific dogma must be accepted on faith without quantification. Where pseudoscience and dogma are completely satisfied with the memorization of a set of words in a particular order as an acceptable final answer for which we need not and must not inquire further, science holds the goal of understanding the practical use and limitations of a concept or piece of knowledge. Quantification of scientific knowledge and scientific conclusions, when it is difficult or impossible to achieve a direct physical measurement relies on statistics. Both frequentist inference and Bayesian inference are fundamental to the practice of science.

Statistics, as the language of science, allows us to move beyond impressionistic and subjective statements towards quantifying some of the complex phenomena that are very real though also very difficult or impossible to observe directly with our senses. As it turns out some of the most interesting things that we may wish to measure are actually very difficult or impossible to measure – things like a person’s personality, level of intelligence, or deception and truth-telling. Mundane things like a person’s height and weight are easy to measure. Measurement requires two things: 1) a physical phenomena and 2) a defined unit of measurement. When we lack these two things and still desire to quantify some phenomena, we use statistics.

Statistics is related to probability and chance. The practical application of statistics in science goes back about 2 or 3 centuries. But the practical application of probabilities outside of science may go back much further – in gaming and wagering. Early statisticians like Bayes and Laplace would have been uninterested in gaming, though today statistics and probabilities play an important role in sports, sports betting and wagering of all kinds in addition to their important roles in business, science, and even politics.

Believable or not, some people have, at times, suggested that statistics is not fun, that statistics is difficult, and even that statistics is boring. In fact, statistics is all of these – statistics is not
for the weak minded or faint-of-heart. Statistics is not for people who cannot find patience or attention for details. In fact, statistics is not for wimps. However, learning about statistics is much less boring and difficult – or at the very least it is more tolerable – when there is some very interesting or very important problem to solve. The logic of frequentist inference is not immediately intuitive for some, but most people can develop their intuition for statistics by learning a few basic concepts. Fortunately for most professionals in field practice versus research or academic work, it is rarely necessary today for humans to do the actually statistical math – for that we have computers. It is very important, however, that professionals who desire to serve their agencies and communities as experts and not mere practitioners should feel some obligation to learn the basic principles of science and statistics – beginning with the fundamentals of frequentist and Bayesian inference.
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