Back to Pontificating about Sweat

Glands Act as Resistors in Parallel

- Resistance will therefore decrease with increased recording surface area – keep surface area constant across subjects
- Resistance is not linearly related to the # of resistors
  \[ \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots \]
- Conductance, however, is linearly related to the number of resistors in the circuit
  - Therefore, there exists a linear relation between measures of conductance and sweat secretion
  - Not so for Resistance
  - The metric of conductance more accurately reflects the activity of the system

<table>
<thead>
<tr>
<th></th>
<th>SRL (Ω)</th>
<th>SCL (μS)</th>
<th>SRR</th>
<th>SCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 Pre</td>
<td>100,000</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1 Post</td>
<td>99,000</td>
<td>10.1</td>
<td>1000</td>
<td>0.1</td>
</tr>
<tr>
<td>R2 Pre</td>
<td>20,000</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2 Post</td>
<td>19,000</td>
<td>52.6</td>
<td>1000</td>
<td>2.6</td>
</tr>
</tbody>
</table>

- Conductance is the Reciprocal of Resistance
- This shows how two vastly different responses will appear the same using skin resistance response metrics

Anatomy of a Gland and the Skin

- Sweat glands primarily driven by sympathetic innervation that is cholinergic
- Sudomotor fibers originate in the sympathetic chain, terminals on sudomotor cell of sweat gland
- Stratum Corneum acts as a variable resistor, with decreased resistance due to sweat

From Dawson et al 2007
Recording -- Placement

From Dawson et al 2007

Recording Considerations

- Prep the Skin?
- Never abrade
- Don’t use other agents (ETOH)
- Washing with soap and H2O recommended to standardize across subjects
- Electrodes – Ag-AgCl
- More expensive and fragile (unless sintered)
- But well worth it – resist polarization
- Conductive Paste
- Because current passed continuously, can interact with with the tissue
- Unibase + physiological saline (Fowles et al, 1981) will keep properties of tissue and paste constant over duration of recording session
- Other gels are bad news;
- Temporal responsivity – SC system is S...L...O...W

Scoring Issues

- Responses that ride on responses
- Range Correction (Lykken et al., 1966)
  - Level
    \[
    \frac{SCL_{\text{max}} - SCL_{\text{em}}}{SCL_{\text{max}} - SCL_{\text{em}}}
    \]
  - Response
    \[
    \frac{SCR_{\text{max}} - SCR_{\text{em}}}{SCR_{\text{max}}} \]
- Note also slope and intercept regression approaches

The Generic SCR

From Dawson et al 2007

Applications

- Orienting (Bauer, 1984; Tranel and Damasio, 1985)
- Fear conditioning (Öhman)
- Individual Differences in Neuroticism
- Deficient anticipatory anxiety in psychopathy (Hare)
- Deception Detection (Myriad authors)
Applications

- Orienting (Bauer, 1984; Tranel and Damasio, 1985)
- Fear conditioning (Öhman)
- Individual Difference
- Deficient anticipatory anxiety (Hare)
- Deception Detection

Neuroticism

- A trait-like tendency to experience negative affect and for increased reactivity to stress and aversive stimuli
- Would skin conductance reflect greater physiological reactivity to negative stimuli, and poorer physiological recovery?

Norris, Larsen, & Cacioppo (2007), *Psychophysiology*

Anticipatory Arousal in Psychopathy

- Hare Countdown Task (1965)
- #'s appear from 1..8
- At “8” punishment is given (shock):

“Lie” Detection: The Problematic Polygraph Test and Some Alternatives

“I don’t know anything about lie detectors other than they scare the hell out of people.”

-- Richard Nixon

People Sometimes Lie
An Armchair Taxonomy Of Lies

- Little Harmless Lies
- The Social Graces
- All Other Lies
  - Accusations
    - about parental habits
    - about fidelity
    - about abuse: physical, sexual
  - Inaccuracies
    - income
    - assets
  - Denials
    - about parental habits
    - about fidelity
    - about abuse
    - about income
    - about assets

The Difficulty in Detecting Lying

Observer Group | Accuracy
--- | ---
Secret Service | 64.1
Federal Polygraphers | 55.7
Robbery Investigators | 55.8
Judges | 56.7
Psychiatrists | 57.6
Special Interest | 55.4
College Students | 52.8

*chance = 50%

from Eckman & O'Sullivan, 1991

The Polygraph and the American Psyche

Lady 1: [My coworker]'s husband is being sent to polygraph school in Atlanta for three weeks so he can give the polygraph test.

Lady 2: Cool! That's like the test that can read your mind, right?

Conversation overheard in W. Lafayette, Indiana, December, 1990

What we, the American people, are witnessing is the beginning of the end of mankind's search for an honest witness. For the first time in the history of civilization, mankind has the opportunity to prove beyond a reasonable doubt the veracity of his testimony through a generally accepted and scientific (sic) valid examination of his own psyche. God gave us the polygraph.


Roadmap

- Abbreviated History and Overview of the Conventional Polygraph
- Limitations to Conventional Polygraphy
- Overview of alternatives: Assessing recognition
The Polygraph Test

Fundamental assumption:

Physiological responding differs when one is truthful versus being deceptive

Note: Detects physiological responses, but not lying per se

Uses (and abuses) of Polygraph Tests

- **Employee Polygraph Protection Act (EPPA; 1988)**
  - Prohibits screening tests for employment in the private sector
  - Allows tests for those reasonably suspected of involvement in a workplace incident
  - "Friendly" tests to the currently employed and to criminal defendants still permitted
  - Federal, State, and Local Government Employers, Federal Contractors, and Police can still use for screening!

- **Expansion of Testing?**
  - National Defense Authorization Act of 2000 requires scientists at nuclear weapons laboratories to submit to polygraph tests to maintain their security clearance
  - "Maintenance polygraphs"

- **Specific Incident Investigations**
  - Criminal Investigations: Defendants, Complainants, Witnesses
  - Insurance Claims Investigations
  - Investigating Prison Inmates Accused of Violating Rules
  - Substantiation of Claims Made in Civil Suits
  - Accusations of parental wrongdoing
  - Paternity Suits

- **Screening Situations**
  - Pre-employment Screening
  - Screening of Current Employees
  - Child Custody Cases
  - Convicted Sex Offenders

- **Instrumentation and Measures**
  - Polygraph examinations involve multi-channel recorders in a flightcase.
  - Typically recorded:
    - Respiration
    - Cardiovascular activity (BP, HR)
    - Skin resistance
  - These measures:
    - provide an indication of changes in autonomic activity
    - do not index the "lie response"
Office of Technology Assessment 1983 report:
"There is no known physiological response that is unique to deception."

Thus...

Anyone who claims to measure lying ... ... is lying!

**Approaches to Detecting Deception**

<table>
<thead>
<tr>
<th>Emotion/Arousal</th>
<th>Memory/Recognition</th>
<th>Other Cognitive Correlates</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The” Polygraph</td>
<td>Guilty Knowledge Test</td>
<td>Response Conflict</td>
</tr>
<tr>
<td>Facial Expression</td>
<td>Autonomic (SCR)</td>
<td>Attention and Memory Load</td>
</tr>
<tr>
<td>Voice Stress</td>
<td>Central (ERP, fMRI)</td>
<td>Both ERP and fMRI</td>
</tr>
<tr>
<td>Facial Blood Flow</td>
<td></td>
<td>Linguistic Analysis</td>
</tr>
<tr>
<td>Thermography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demeanor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note that none detect lying *per se*

**The Polygraph Examiner**

- Requisite skills
  - Knowledge of test construction
  - Knowledge of the basic psychometric properties of tests: reliability and validity
  - Clinical interviewing skills
  - Knowledge of physiology of the autonomic nervous system
  - Knowledge of autonomic psychophysiological recording, scoring, and interpretation
  - Knowledge of the ethics of administering and reporting the results from psychological tests; limits of interpretation, limits of confidentiality
- Training
  - Graduated from professional polygraph training school, which are administered and staffed primarily by professional polygraphers (31 schools accredited by the American Polygraph Association (APA) in the U.S. and Canada)
  - Curriculum spans a minimum 320 hours

**What is the Polygraph Test?**

**Control Question Test (CQT; John Reid, 1947)** (for Specific Incidents Investigations)

- Approximately 10 questions
- Relevant Questions
  - address the subject matter under investigation
- Control Questions
  - questions developed by the examiner after a pretest interview with the subject
  - address generally questionable behavior
- The pretest interview stresses 2 ways to fail test, and that test is infallible
CQT “Theory” (Raskin, 1982)

- Innocent subjects should react with stronger emotion to the Control questions since their content are of greater direct concern.
- Guilty subjects should respond with stronger emotion to the Relevant questions.
- Comparing the magnitude of the responses (usually skin-resistance) to the control and relevant questions yield a verdict of Guilty, Innocent, or Indeterminate.

“CONTROL” TEST QUESTIONS

- Did you touch Susie between her legs?
- Have you found teen girls attractive?
- Have you been naked in sight of Susie?
- Have you lied to try to stay out of trouble?
- Have you viewed pornography?
- Have you fantasized sexually about Susie?

Control Question Test (CQT; John Reid, 1947)
(for Specific Incidents Investigations)

- Approximately 10 questions
- Relevant Questions
  - address the subject matter under investigation
- Control Questions
  - questions developed by the examiner after a pretest interview with the subject
  - address generally questionable behavior
- At least 3 separate charts (i.e. 3 separate presentations of the set of questions) are administered
- The pretest interview stresses 2 ways to fail test, and that test is infallible

Hypothetically...

Innocent

- Deception

Guilty

Typical Scoring — Semiobjective Method

- Each relevant question paired with a "control" item adjacent in the sequence of questioning
  - A score of -1 to -3 is assigned if response to relevant item is (a little, somewhat, clearly) larger than response to control item
  - A score of +1 to +3 is assigned if response to relevant item is (a little, somewhat, clearly) smaller than response to control item
- Separate scores derived for each channel, and scores are summed over charts, channels, and question pairs
  - Total score < -6: DECEPTIVE
  - Total score > +6: TRUTHFUL
  - -5 < Total score > +5: INCONCLUSIVE

Typical Scoring (less than objective method)

- Polygrapher uses a global impressionistic decision-making strategy that incorporates:
  - Case facts
  - Examinee behaviors
  - Polygraph Chart data
  - Examiner’s "professional" hunches and impressions
The Importance of Blind Scoring

- Expectancy Effects (the "60 Minutes study")
- Three polygraph firms each examined four employees accused of theft of a camera (none actually stolen)
- Without the knowledge of the employees, each polygrapher was told that a different employee was suspected by management
- In each instance, the suspected employee was deemed guilty (probability by chance = 1.5%)

Validity and Ethical Concerns:
Examine the Assumptions

- Assumptions that must be met in order for the CQT to produce valid results:
  - Examiner formulates relevant questions that guilty subjects will answer deceptively (reasonable)
  - Examiner constructs control questions that subjects will answer untruthfully or with some doubt as to their veracity (plausible, but difficult)
  - An innocent person will be more disturbed by the control questions than by the relevant questions (implausible)
  - A guilty person must be more disturbed more by the relevant questions (reasonable)

The CQT Box Score

<table>
<thead>
<tr>
<th></th>
<th>% Correctly Classified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Polygrapher's Research</td>
<td>Guilty</td>
</tr>
<tr>
<td>Horvath &amp; Reid (1971)</td>
<td>85</td>
</tr>
<tr>
<td>Hunter &amp; Ash (1973)</td>
<td>88</td>
</tr>
<tr>
<td>Stocnick &amp; Buckley (1975)</td>
<td>85</td>
</tr>
<tr>
<td>Wicklander &amp; Junter (1975)</td>
<td>92</td>
</tr>
<tr>
<td>Davidson (1979)</td>
<td>90</td>
</tr>
<tr>
<td>Yankee, Powell, &amp; Newland (1976)</td>
<td>100</td>
</tr>
<tr>
<td>Weighted Total</td>
<td>91</td>
</tr>
</tbody>
</table>

Social Scientist's Research

<table>
<thead>
<tr>
<th></th>
<th>% Correctly Classified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartenda &amp; Raskin* (1976)</td>
<td>98</td>
</tr>
<tr>
<td>Horvath (1977)</td>
<td>77</td>
</tr>
<tr>
<td>Kleinmuntz &amp; Szucko (1984)</td>
<td>75</td>
</tr>
<tr>
<td>Iacono &amp; Patrick (1988)</td>
<td>96</td>
</tr>
<tr>
<td>Weighted Total</td>
<td>88</td>
</tr>
</tbody>
</table>

* is also a trained polygrapher

Effects of Enhancing Realism in Laboratory Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Group</th>
<th>N</th>
<th>Guilty</th>
<th>Innocent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raskin &amp; Hare</td>
<td>Psychopath</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1978)</td>
<td>Nonpsychopath</td>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* after Iacono & Patrick, 1997

Roadmap

- Abbreviated History and Overview of the Conventional Polygraph
- Limitations to Conventional Polygraphy
- Overview of alternatives: Assessing recognition

Types of Validity Studies

- Laboratory: Mock Crime
- Field: Real Life Cases
### Effects of Enhancing Realism in Laboratory Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Group</th>
<th>N</th>
<th>Guilty</th>
<th>Innocent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raskin &amp; Hare (1978)</td>
<td>Psychopath</td>
<td>23</td>
<td>100</td>
<td>~92</td>
</tr>
<tr>
<td></td>
<td>Nonpsychopath</td>
<td>20</td>
<td>100</td>
<td>~90</td>
</tr>
<tr>
<td>Patrick &amp; Iacono (1989)</td>
<td>Psychopath</td>
<td>20</td>
<td>83</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Nonpsychopath</td>
<td>21</td>
<td>91</td>
<td>50</td>
</tr>
</tbody>
</table>

### Problems with Field Studies

- How is ground truth established?
  - Judicial verdicts inadequate
  - Plea bargains and false convictions
  - Evidence not beyond a reasonable doubt
  - Judicial verdict may be influenced by outcome of polygraph!
  - Therefore, confessions are used to identify the culpable and to clear the innocent.
- Confessions gathered only after the subject has failed the test, which leads to an unfortunate selection bias.

### Why Using Confessions Overestimates Accuracy

- **Passed Polygraph**
  - Guilty: No Confession (False Negative: 0%)
  - Not Selected: Confession (True Positive: 100%)

- **Failed Polygraph**
  - Guilty: Confession of another accused
  - Not Selected: Selected (True Negative: 100%)

- **In Fact Guilty**
  - Passed Polygraph: No Confession
  - Failed Polygraph: Confession of another accused

- **In Fact Innocent**
  - Passed Polygraph: Confession
  - Failed Polygraph: No Confession

### Feedback Polygraphers Receive

- **In Fact Guilty**
  - Passed Polygraph: Confession
  - Failed Polygraph: Confession of another accused

- **In Fact Innocent**
  - Passed Polygraph: No Confession
  - Failed Polygraph: Selected (True Positive: 100%)

100% of those who confess failed the polygraph!
Screening Tests

- Because these tests have much higher false negative rates than false positive rates, they should not be used in instances where most folks are innocent.

<table>
<thead>
<tr>
<th>Test Verdict</th>
<th>Actual</th>
<th>Guilty</th>
<th>Not Guilty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guilty</td>
<td>9</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Not Guilty</td>
<td>40</td>
<td>50</td>
<td>90</td>
</tr>
</tbody>
</table>

Total correct verdicts = 59%

Implications

- If most accused folks are not culpable, a very large number of False-Positives will result.
- Impact of False-Positives on the accused and the family.
- Cumulative risk of False-Positives with Maintenance Polygraph Tests is substantial (and no evidence to suggest that maintenance polygraphs are effective, Meijer et al. 2008, Int J Law Psych).
- Countermeasures can reduce True Positive rate.

Probability a guilty verdict is correct: 18.4%

NRC (2003) Key Conclusions

- “What is remarkable, given the large body of relevant research, is that claims about the accuracy of the polygraph made today parallel those made throughout the history of the polygraph: practitioners have always claimed extremely high levels of accuracy, and these claims have rarely been reflected in empirical research.”

- “Almost a century of research in scientific psychology and physiology provides little basis for the expectation that a polygraph test could have extremely high accuracy.”

Meta-Analytic Survey” by APA

- Ad-hoc Committee (Mike Gougler, Raymond Nelsen, Mark Handler, Donald Krapohl, Paul Shev, Leonard Bierman)
- Scope:
  - 45 samples (majority in Polygraph, many by Raymond Nelson)
  - 295 scorers
  - 11,737 examinations
- Omnibus accuracy 86.9% (23.5% inconclusive)
- No breakdown of false-positive & false-negative
- Critical admission:
  - “Real world confirmation data are selective … and confirmed cases more often may have correct PDD results than do unconfirmed cases. As a result, field studies may overestimate PDD decision accuracy to some degree.”
To strategically plan for and ensure our survival in the years ahead, the APA has been implementing initiatives...

... specific-incident polygraph tests can discriminate lying from truth telling at rates well above chance, though well below perfection. ... polygraph accuracy for screening purposes is almost certainly lower than what can be achieved by specific-incident polygraph tests in the field.

The GKT as an alternative to Traditional Polygraph Procedures

- Guilty Knowledge Test (GKT)
  - Devised by Lykken (1959)
  - Sometimes termed Concealed Information Test (CIT)
  - Can utilize Skin Conductance or other measures (e.g. Event-Related Brain Potentials)
- Sometimes termed “Concealed Information Test” (CIT)

Guilty Knowledge Test (GKT)

- The GKT does not assess lying as indexed by fear of being detected, but probes for guilt as indexed by recognition
- A series of questions is devised, each having several alternatives, only one of which is true about the crime in question
- Chances of an innocent person looking guilty on a 10-item GKT are 1/5^10.

Assessing Recognition: For Specific Incidents Investigations

- Used when information about a crime or event is available that only a real culprit would know
- Series of questions constructed, only one of which has correct critical detail

<table>
<thead>
<tr>
<th>Regarding the abduction location, do you know for sure it was...</th>
<th>Other questions about...</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ... at a Toy Store?</td>
<td>Time abducted taken...</td>
</tr>
<tr>
<td>2. ... at a Shopping Mall?</td>
<td>Clothing worn...</td>
</tr>
<tr>
<td>3. ... at a City Park?</td>
<td>etc. for 6-10 questions</td>
</tr>
<tr>
<td>4. ... at a Friend’s House?</td>
<td></td>
</tr>
<tr>
<td>5. ... at School?</td>
<td></td>
</tr>
<tr>
<td>6. ... at a Restaurant?</td>
<td></td>
</tr>
</tbody>
</table>

- Subject instructed to answer "no" to each item, so that if guilty, subject would be lying to the critical item.
- Critical item never positioned at beginning.
- A consistent peak of physiological response on one critical alternative suggests guilt.

GKT Accuracy: Lab Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lykken '59</td>
<td>98</td>
<td>88  100</td>
</tr>
<tr>
<td>Davidson '68</td>
<td>48</td>
<td>92  100</td>
</tr>
<tr>
<td>Podlesney '78</td>
<td>18</td>
<td>90  100</td>
</tr>
<tr>
<td>Balloun '79</td>
<td>34</td>
<td>61  88</td>
</tr>
<tr>
<td>Giesen '80</td>
<td>40</td>
<td>92  100</td>
</tr>
<tr>
<td>Bradley '81</td>
<td>192</td>
<td>59  89</td>
</tr>
<tr>
<td>Bradley '84</td>
<td>16</td>
<td>100 100</td>
</tr>
<tr>
<td>Iacono '84</td>
<td>55</td>
<td>91  100</td>
</tr>
<tr>
<td>Steller '87</td>
<td>87</td>
<td>85  100</td>
</tr>
<tr>
<td>Iacono '92</td>
<td>71</td>
<td>87  71</td>
</tr>
<tr>
<td>O'Toole '94</td>
<td>45</td>
<td>77  94</td>
</tr>
</tbody>
</table>

Study Median 48 88 100
GKT – Box Score, and Concerns

- Superior to CQT, especially in protecting the innocent
- Resistance to use among those in the polygraph community
  - Concern about applicability, especially in high profile cases
  - The GKT for OJ
- Despite limitations of CQT, may have utility for eliciting confessions
- Over 5,000 GKT tests given in Japan each year, for example

Countermeasures?

- Iacono et al. (1984, 1987) increased incentives and found no effects (relative to placebo) for:
  - Diazepam (widely prescribed tranquilizer)
  - Methylphenidate (stimulant)
  - Meprobamate (tranquilizer)
  - Propranolol (widely prescribed cardiac med. β-blocker that inhibits SNS activity)
- Overall hit-rate for the guilty was >90%

Physical Countermeasures?

- Honts et al. (1983, 1984) found that 78% of highly motivated subjects could be trained to "beat" the CQT by biting their tongues or pressing their toes to the floor during control questions
  - Although it took training, motivated suspects could easily obtain it or it could be provided, especially when stakes are high (e.g., foreign agents being screened for national security positions)
- The polygraphers were unable to detect these subtle maneuvers
- "Counter-countermeasures" worked to detect those using countermeasures: 80% of those using countermeasures could be detected by a blind analysis of EMG recordings
  - Such counter-countermeasures rarely used in field polygraphy
- The rectangularity score of the GKT should -- in theory -- be much less susceptible to these techniques
  - GKT and rectangularity scores rarely used in field polygraphy
  - Yet Honts et al. (1996) found that both Physical (pressing toes to floor) and mental (counting backwards by sevens) countermeasures reduced the validity of the GKT (Overall accuracy dropped from 85% to 25%)

Synopsis

- There is no unequivocal lie response
- Polygraphy:
  - assesses emotional reactions
  - has an unacceptably high false-positive rate
  - is vulnerable to countermeasures that can reduce true-positive rate
- Polygraphers overestimate accuracy due to how cases are selected for inclusion in studies
- Assessing recognition may prove more accurate, but potentially less widely applicable
- Polygraphs are useful for eliciting admissions and confessions; i.e. “scare the hell out of people”

jallen.faculty.arizona.edu/polygraph