Back to Pontificating about Sweat

Anatomy of a Gland and the Skin

Figure 7.1. Anatomy of the eccrine sweat gland in various layers of skin. (Adapted from Hassett, 1978).
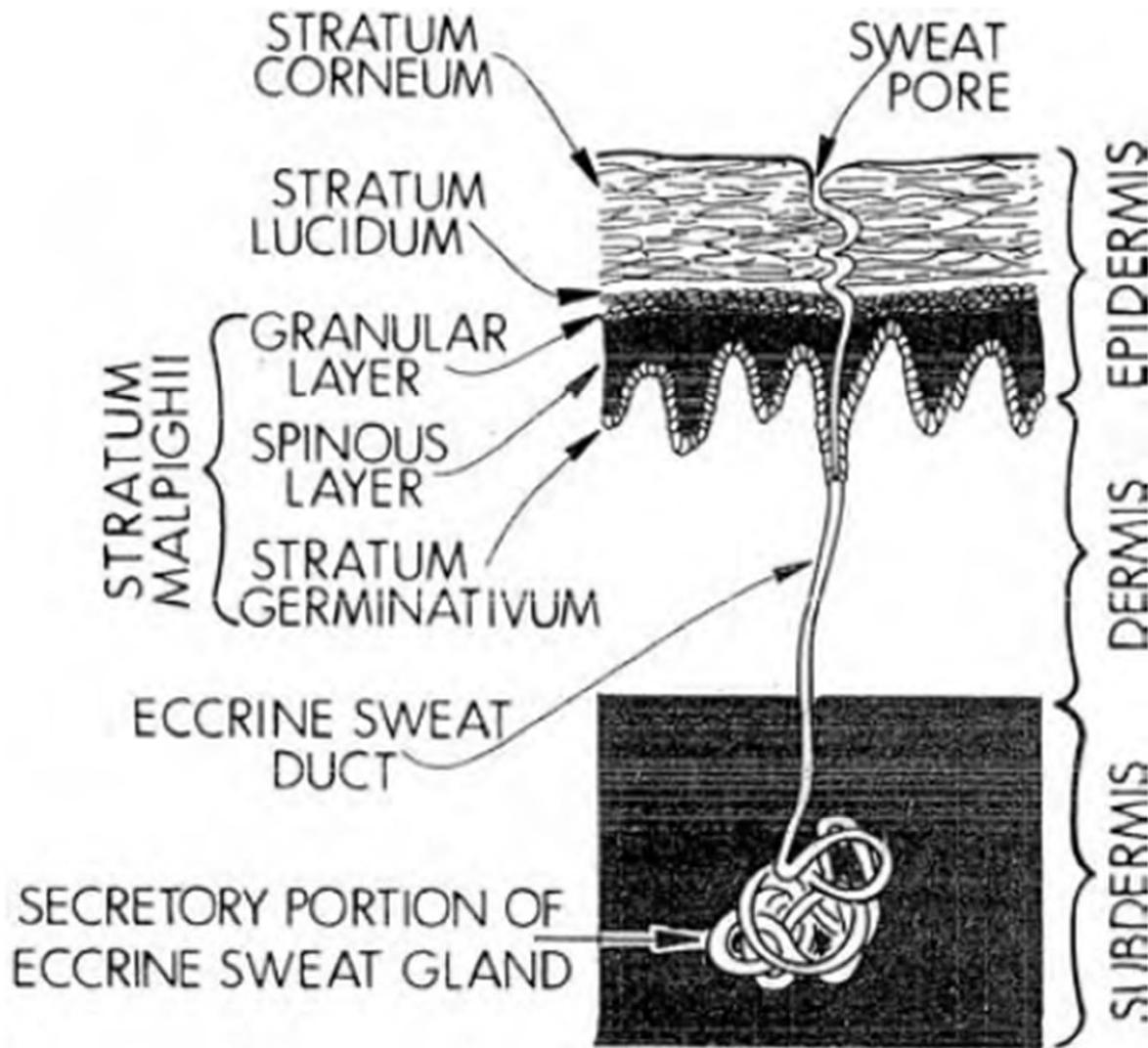
- Sweat glands primarily driven by sympathetic innervation that is cholinergic

- Sudomotor fibers originate in the sympathetic chain, terminate on sudomotor cell of sweat gland

- Stratum Corneum acts as a variable resistor, with decreased resistance due to sweat

From
Dawson et al 2007

Acronym Glossary

- Generic terms
  - EDA = electrodermal activity
  - GSR = galvanic skin response
- Skin Resistance
  - SRL = skin resistance level (tonic); 10,000-500,000Ω
  - SRR = skin resistance response (phasic); 100-10,000 Ω
- Skin Conductance
  - SCL = skin conductance level (tonic); 2-50 μsiemens
  - SCR = skin conductance response (phasic); .05-5 μsiemens
  - SSCR or NSSCR = spontaneous or non-specific skin conductance response
- Skin Potential
  - SPL = skin potential level (tonic); 0-60 mV
 - SPR = skin potential response (phasic); .1-10 mV
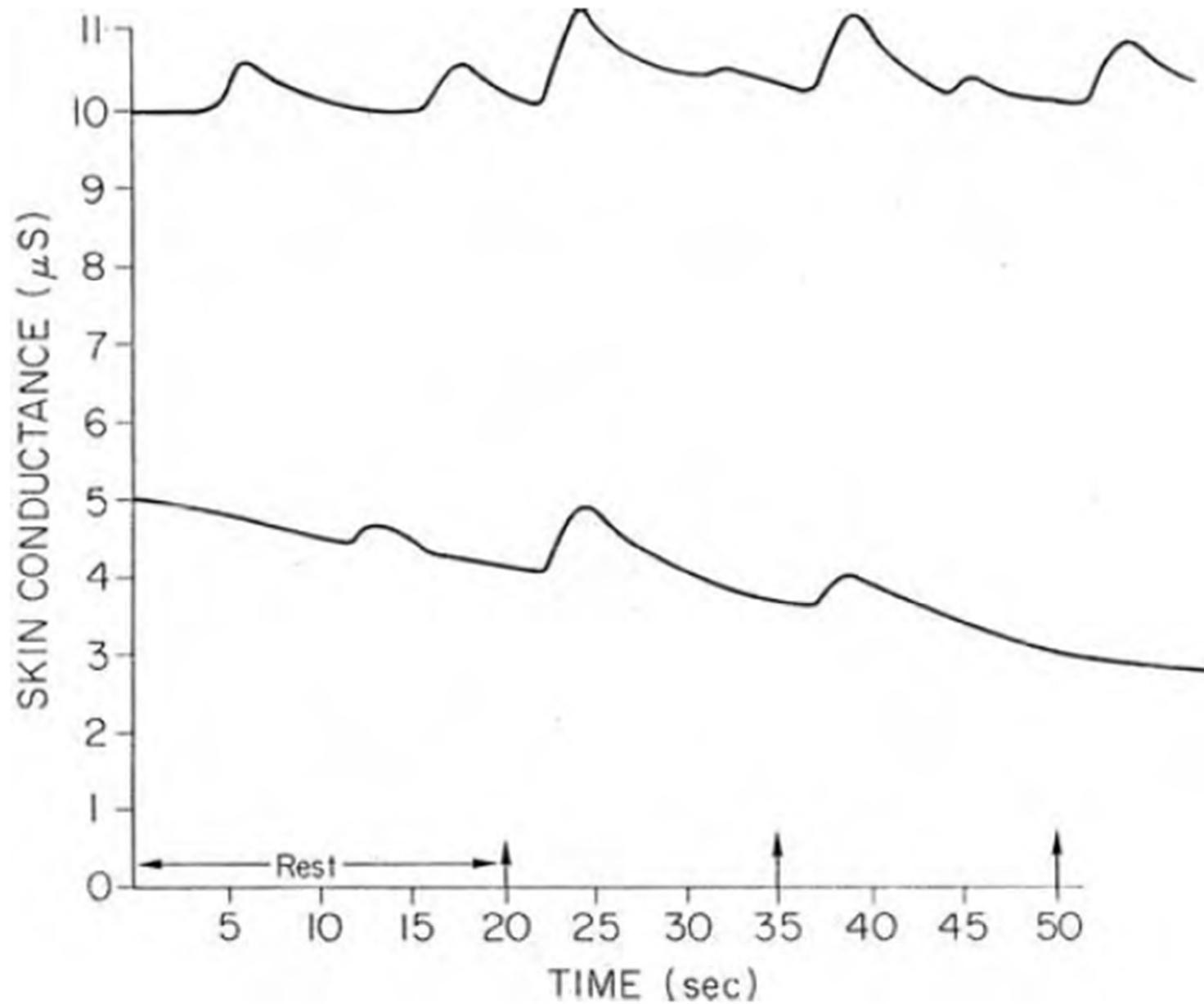
Figure 7.4. Two hypothetical skin conductance recordings during 20 s of rest followed by three repetitions of a simple discrete stimulus. Arrows represent the presentation of a stimulus (From Dawson & Nuechterlein, 1984).

Table 7.1. Electrodermal measures, definitions, and typical values

Measure	Definition	Typical Values
Skin conductance level (SCL)	Tonic level of electrical conductivity of skin	2–20 μS
Change in SCL	Gradual changes in SCL measured at two or more points in time	1–3 μS
Frequency of NS-SCRs	Number of SCRs in absence of identifiable eliciting stimulus	1–3 per min
SCR amplitude	Phasic increase in conductance shortly following stimulus onset	0.1–1.0 μS
SCR latency	Temporal interval between stimulus onset and SCR initiation	1–3 s
SCR rise time	Temporal interval between SCR initiation and SCR peak	1–3 s
SCR half recovery time	Temporal interval between SCR peak and point of 50% recovery of SCR amplitude	2–10 s
SCR habitation (trials to habituation)	Number of stimulus presentations before two or three trials with no response	2–8 stimulus presentations
SCR habituation (slope)	Rate of change of ER-SCR amplitude	0.01–0.5 μS per trial

Key: SCL, skin conductance level; SCR, skin conductance response; NS-SCR, nonspecific skin conductance response.

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

$$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

➢ 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

The re
to elec

LAUREN V
ADRIAN R
[a] Department o
[b] Department o
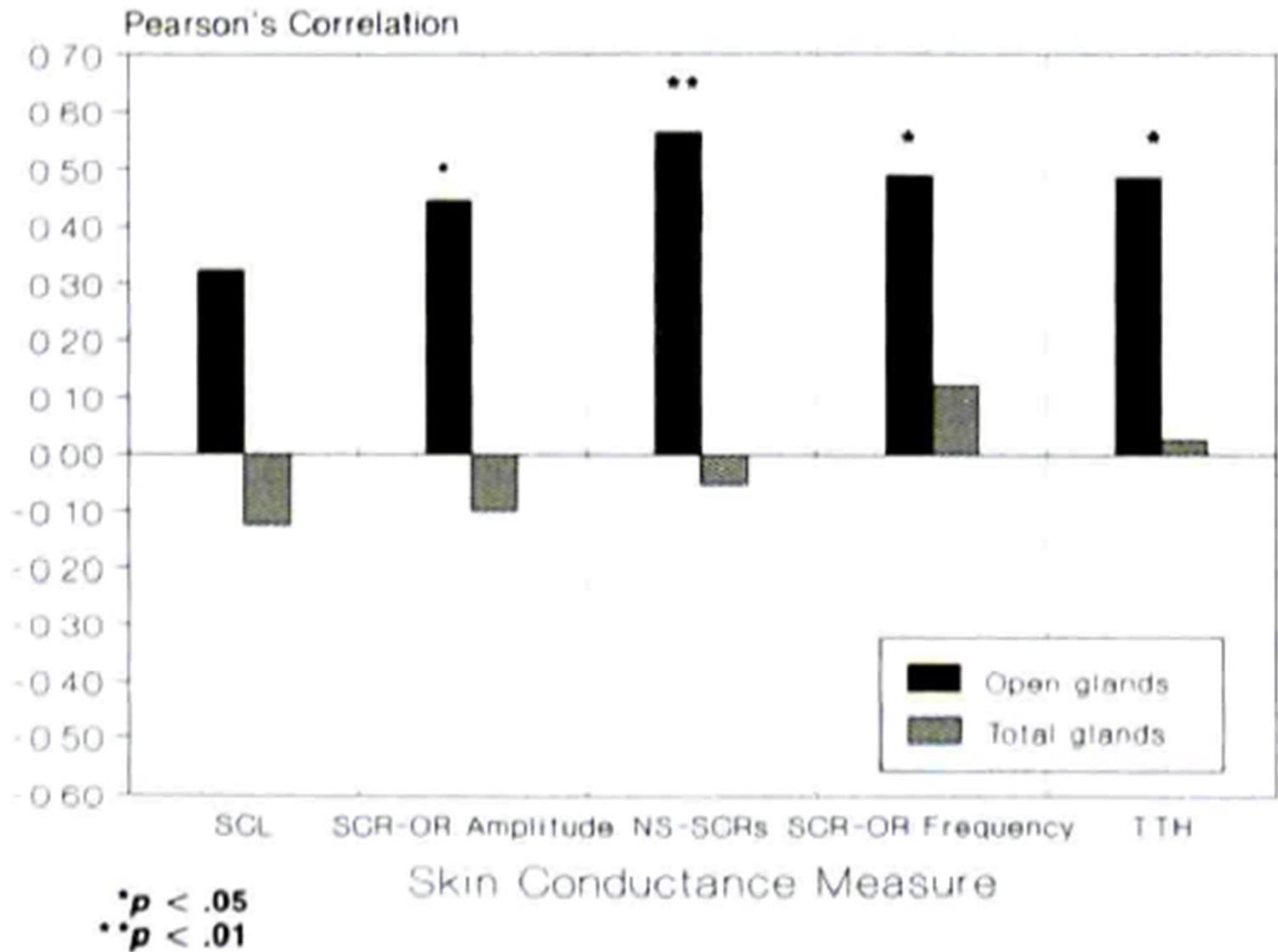
Figure 1. Pearson's correlations of number of open and total glands with skin conductance level (SCL), skin conductance orienting response (SCR-OR) amplitude, frequency of nonspecific responses (NS-SCRs), frequency of SCR-ORs, and trials to habituation (TTH).

	SRL (Ω)	SCL(μS)	SRR	SCR
R1 Pre	100,000	10		
R1 Post	99,000	10.1	1000	0.1
R2 Pre	20,000	50		
R2 Post	19,000	52.6	1000	2.6

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

Recording -- Placement
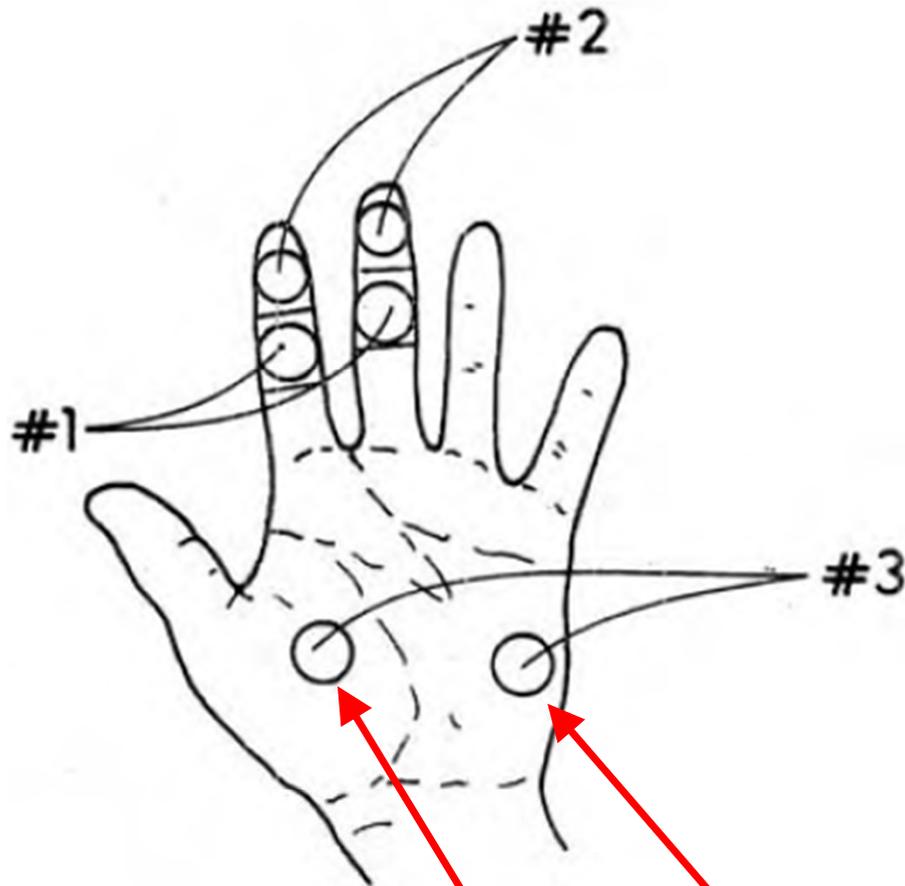
Figure 7.3. Three electrode placements for recording electrodermal activity. Placement #1 involves volar surfaces on medial phalanges, placement #2 involves volar surfaces of distal phalanges, and placement #3 involves thenar and hypothenar eminences of palms.

From Dawson et al 2007

Methodology

A Major Effect of Recording Site on Measurement of Electrodermal Activity

ANGELA SCARPA SCERBO, LAUREN WEINSTOCK FREEDMAN,
ADRIAN RAINE, MICHAEL E. DAWSON,
Department of Psychology, University of Southern California

AND PETER H. VENABLES
Department of Psychology, University of York, England

ABSTRACT

Although the medial phalanx has been recommended as the preferred site for recording skin conductance activity, a review of articles published in *Psychophysiology* indicates that a large minority (34%) of studies employ the distal phalanx. Informal observations also suggest that the distal site may be more reactive than the medial site. This study formally tests this observation by recording skin conductance from both medial and distal phalanges. Twenty-four right-handed subjects (12 male, 12 female) were exposed to a series of 10 orienting and defensive stimuli. Electrodes were placed on the fore and middle fingers of each hand, with distal sites used on one hand and medial sites on the other for each subject. Skin conductance amplitudes were 3.5 times larger at distal than medial sites ($p < .002$), while skin conductance levels were 2.08 times larger at distal sites ($p < .0005$). A significant Site × Stimulus interaction ($p < .025$) indicated that the distal site was more sensitive to habituation over trials and to increases in skin conductance amplitudes with increasing stimulus intensity than the medial site. On the basis of these findings it is recommended that distal sites be used in preference to medial sites in the recording of skin conductance activity.

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;
    ➢ highly conductive, but saturated with NaCl,
    ➢ over time will migrate to skin tissue, inflating SCL
➢ Surface Area Exposed
  ➢ Keep constant across subjects and session
➢ Constant Voltage Amplification
  ➢ Preferred over Constant current (Lykken and Venables, 1971)
➢ Temporal responsivity – SC system is S…L…O…W

The Generic SCR

- Latency typically 1-3 secs
- Rise time typically 1-4 secs
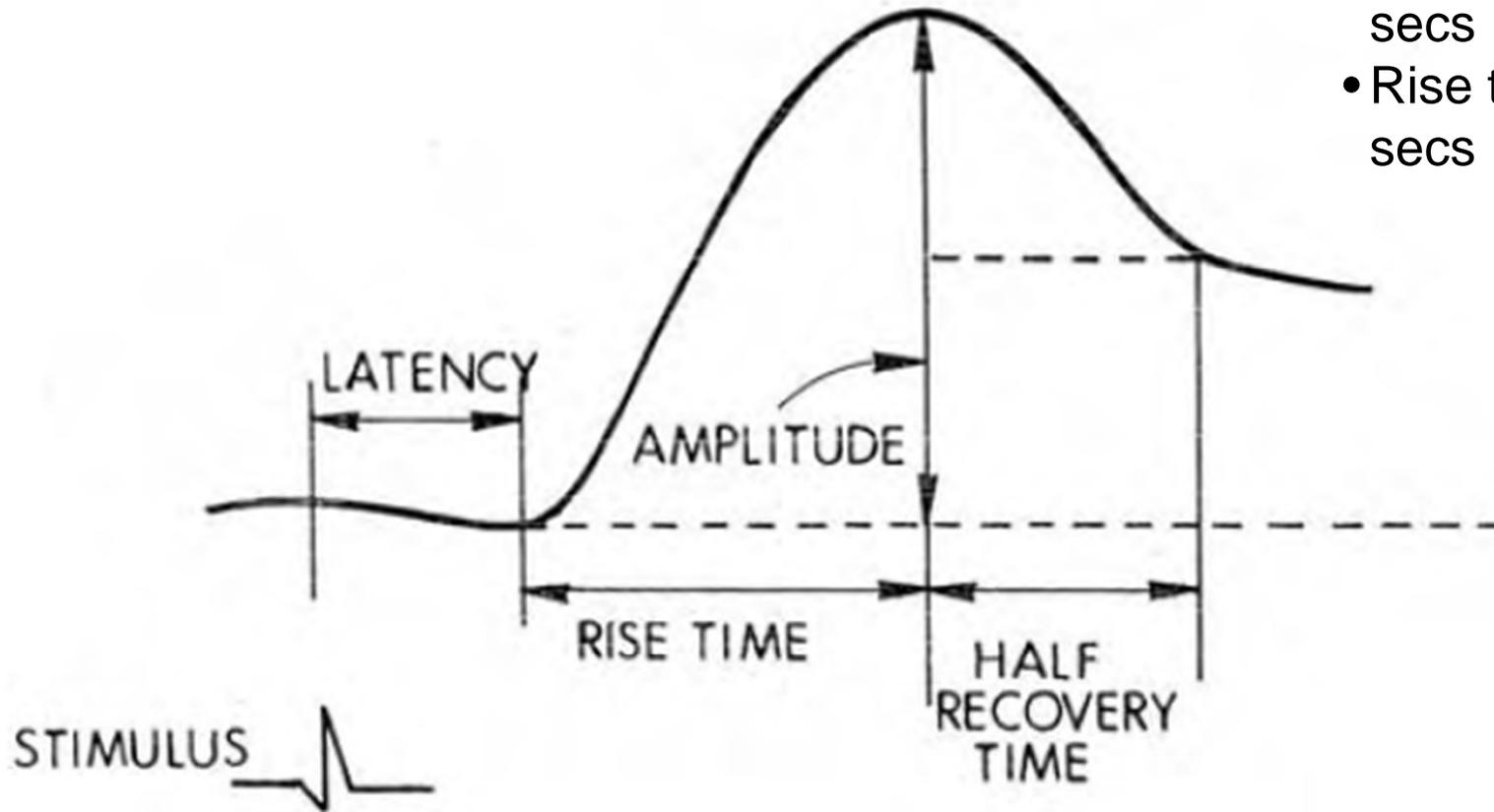
Figure 7.5. Graphical representation of principal EDA components.

From Dawson et al 2007

Scoring Issues

➤ Responses that ride on responses

➤ Range Correction (Lykken et al., 1966)

    ➤ Level

$$\frac{(SCL_{observed} - SCL_{min})}{(SCL_{max} - SCL_{min})}$$

    ➤ Response

$$\frac{(SCR_{observed})}{(SCR_{max})}$$

➤ Note also slope and intercept regression approaches

Applications

➢ <u>Orienting</u> (Bauer, 1984; Tranel and Damasio, 1985)

➢ <u>Fear conditioning</u> (Őhman)

➢ Individual Differences in Neuroticism

➢ Deficient anticipatory anxiety in psychopathy (Hare)

➢ Deception Detection (Myriad authors)

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*
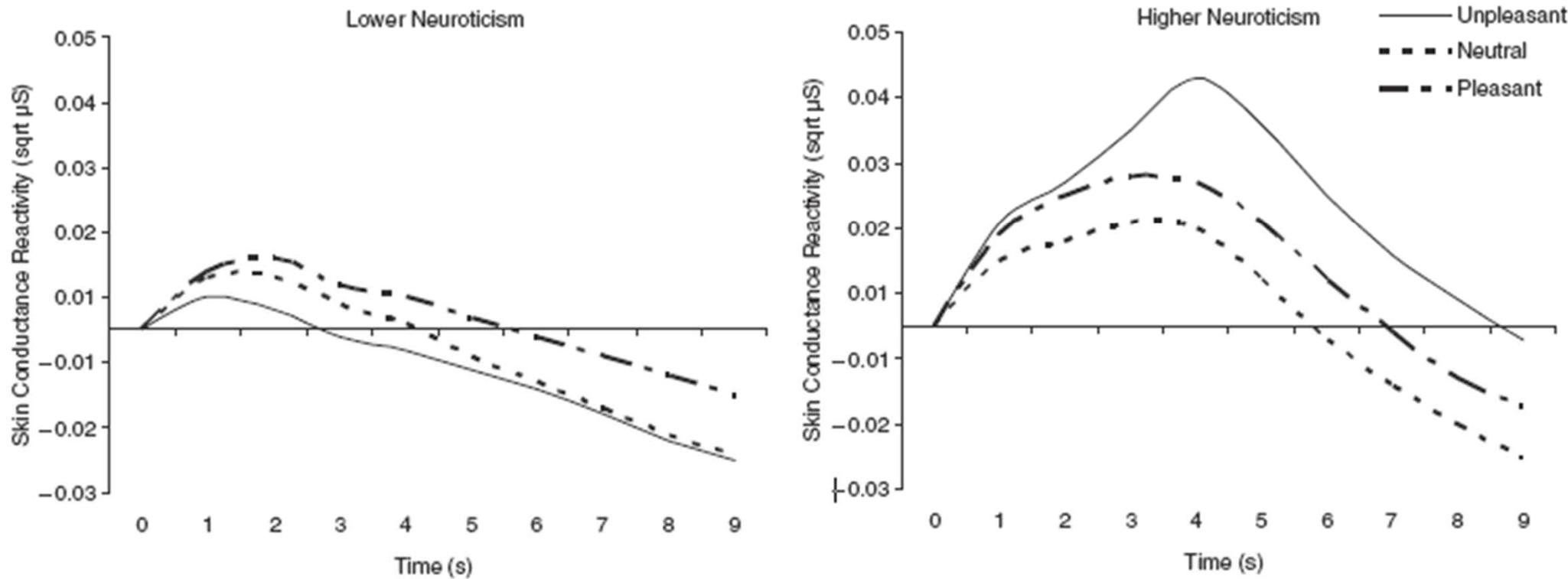
Figure 1. Skin conductance reactivity as a function of picture valence, time, and neuroticism. Pictures were presented from 1–6 s. Estimated means for participants lower (1 *SD* below the mean) and higher (1 *SD* above the mean) in neuroticism are plotted separately.

Anticipatory Arousal in Psychopathy

➤ Hare Countdown Task (1965)

➤ #'s appear from 1..8

➤ At "8" punishment is given (shock):
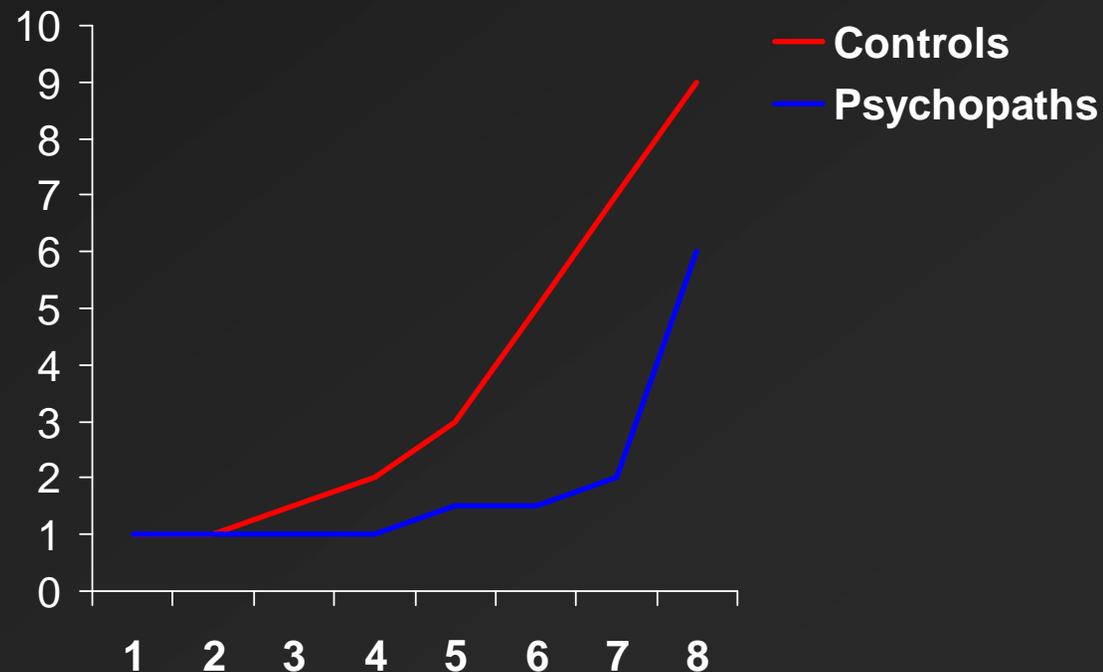
Lie Detection: The Problematic Polygraph Test and Some Alternatives

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

[a]chance = 50%

from Eckman & O'Sullivan, 1991

Talk Overview

➢ Abbreviated History and Overview of the Conventional Polygraph

➢ Limitations to Conventional Polygraphy

➢ Overview of alternatives: Assessing recognition

➢ What are Event-related Potentials (ERPs)?

➢ How can ERPs be used in the detection of deception?

➢ The challenges, promise, & limitations

➢ Future directions

The Polygraph Test

➢Fundamental assumption is that physiological responding:

   ➢differs when one is truthful versus being deceptive,

  or

   ➢demonstrates a specific physiological "lie response."

Uses (and abuses) of Polygraph Tests

➢ **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
- ➢ Paternity Suits

➢ **Screening Situations**

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

➢ **Employee Polygraph Protection Act (EPPA; 1988)**

- ➢ Prohibits Screening Tests for employment in 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

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"

Conventional Polygraphs

Each instrument comes with a one year warranty on all parts and labor. With each four- or five-pen instrument you will receive the following standard accessories: two pneumo chest assemblies, GSR electrode set, standard Kovacic arm cuff, pump bulb assembly, pens and bottles for each recording module, one extra ink bottle, pen pad, ink filler, ink, tool kit, two rolls of chart paper and an instruction manual. Other optional accessories include auto power conversion, in-case calibrator, various styles of event markers and thermal writing capabilities.

The Statesman
Zero® case, the clean Halliburton lines are enhanced by the black morocco grain finish. The case is high-impact thermo-formed ABS plastic to ensure durability. (Total weight: 21.5lbs. or 24.5lbs. with calibrator. Dimensions: 13″W x 21″L x 6.5″D).

The Factfinder II
The 10″ chart drive allows five pens to be used simultaneously with greater pen swing. The practice of "pigeon toeing" the outside pens on a five-pen polygraph is no longer necessary and charts are easier to read because of reduced tracing overlap. This leaves plenty of room for important notations. Every Factfinder II maintains all of the quality and conveniences of our standard 8″ chart drive models. Available only in a Statesman case, no thermal models are available.

The Courier II
Our newest conventional case style offers a gold anodized look and compact size. The case was designed with the traveling examiner in mind. The lid is designed with plenty of storage space and includes an in-case calibrator. The case is made of exceptionally strong, deep-drawn aluminum that resists dents and is also dust and weather resistant. (Total weight: 21.5lbs. Dimensions: 13″W x 18″L x 6.5″D).

EXHIBIT "B"
A CLASSIC "LYING" REACTION

PNEUMO TRACINGS

GSR TRACINGS

CARDIO TRACINGS
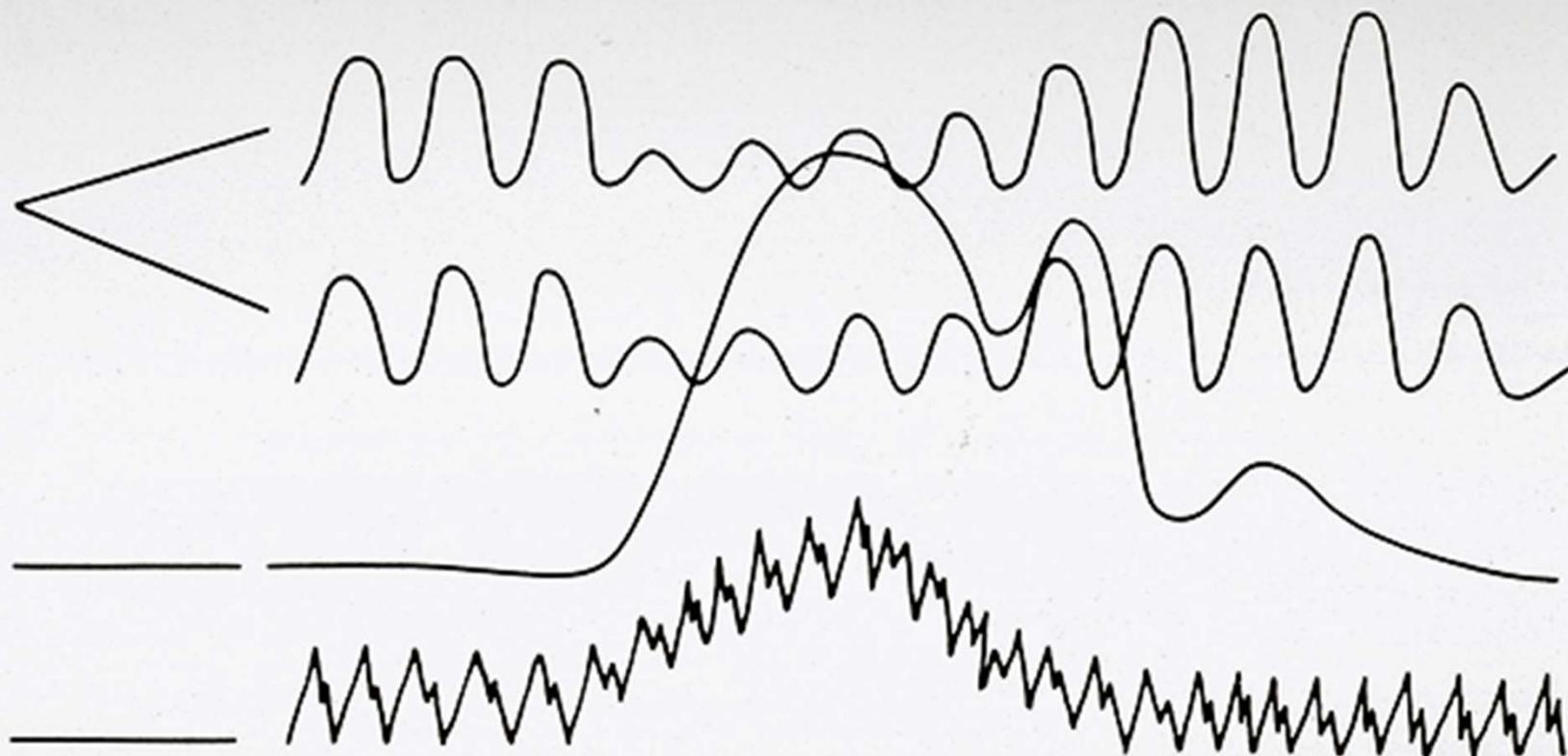
THE POINT AT WHICH THE SUBJECT
ANSWERED A RELEVANT QUESTION.

Approaches to Detecting Deception

Emotion/Arousal	Memory/ Recogntion	Other Cognitive Correlates
➢ "The" Polygraph ➢ Facial Expression ➢ Voice Stress ➢ Facial Blood Flow ➢ Thermography ➢ Demeanor	➢ Guilty Knowledge Test ➢ Autonomic (SCR) ➢ Central (ERP, fMRI?)	➢ Response Conflict ➢ Attention and Memory Load ➢ Both ERP and fMRI ➢ Lingusitic Analysis

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 of 7 weeks

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

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 slap Tommy?**
- **Have you hit anyone?**
- **Did you threaten Tommy?**
- **Have you ever told a lie to stay out of trouble?**
- **Have you ever threatened anyone?**
- **Did you punch Tommy?**

Relevant

"Control"

Hypothetically…

Innocent

Guilty

(a) Innocent: Respiration, Perspiration, and Heart rate traces across Control question and Relevant question periods.

(b) Guilty: Respiration, Perspiration, and Heart rate traces across Control question and Relevant question periods.
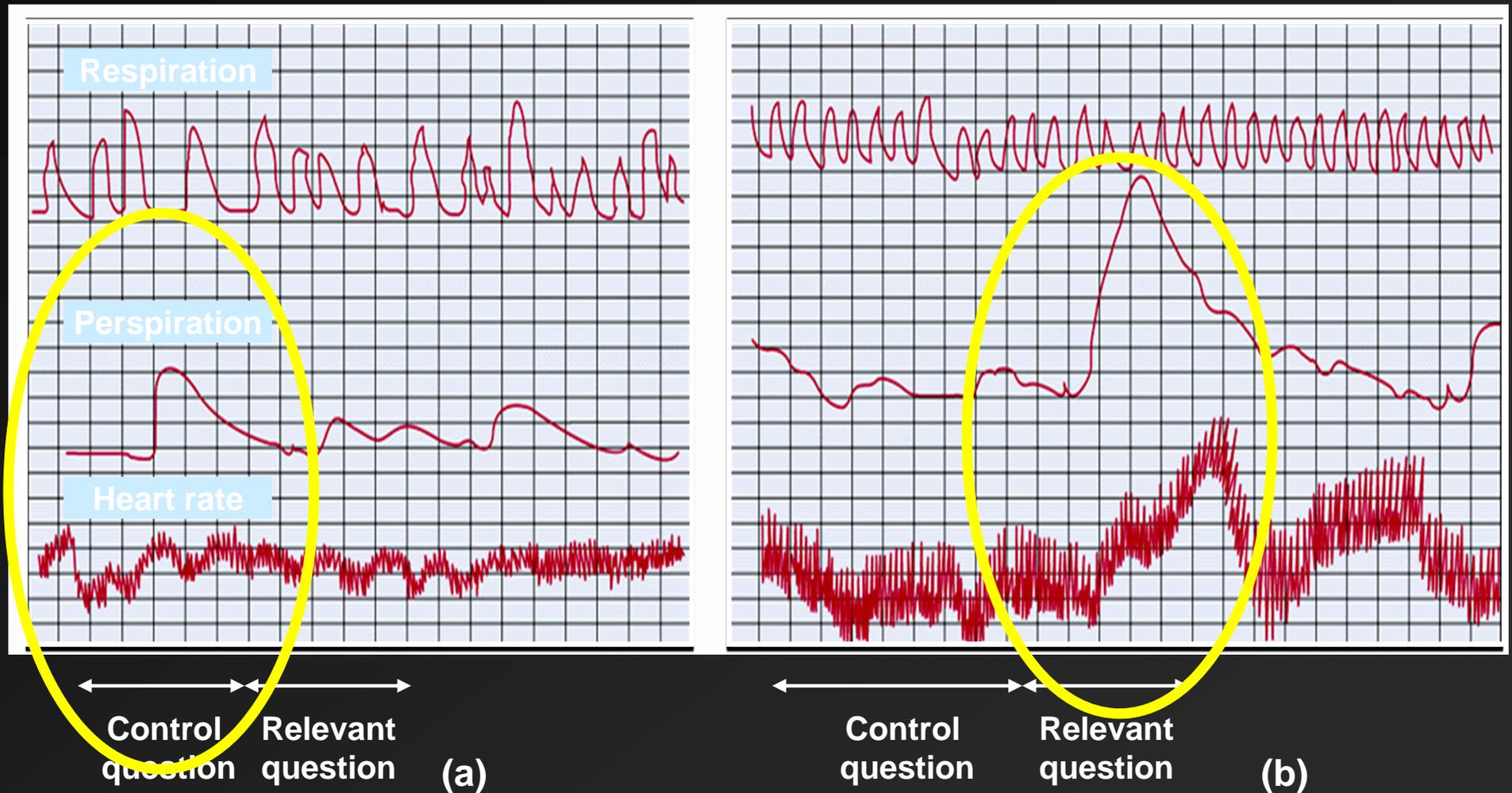
Typical Scoring -- Semiobjective Method

➢ 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

% Correctly Classified

Professional Polygrapher's Research	Guilty	Innocent
Horvath & Reid (1971)	85	91
Hunter & Ash (1973)	88	86
Slowick & Buckley (1975)	85	93
Wicklander & Junter (1975)	92	95
Davidson (1979)	90	100
Yankee, Powell, & Newland (1976)	100	98
Weighted Total	91	94
Social Scientist's Research		
Barlanda & Raskin[a] (1976)	98	45
Horvath[a] (1977)	77	51
Kleinmuntz & Szucko (1984)	75	63
Iacono & Patrick (1988)	98	55
Weighted Total	88	57

[a] is also a trained polygrapher

after **Iacono & Patrick, 1997**
Assessing deception: Polygraph techniques.
In R. Rogers, Ed., Clinical *Assessment of Malingering and Deception*
New York: Guilford.

Types of Validity Studies

➤ Laboratory: Mock Crime

➤ Field: Real Life Cases

Effects of Enhancing Realism in Laboratory Studies

Study	Group	N	% Accuracy	
			Guilty	Innocent
Raskin & Hare (1978)	Psychopath	23		
	Nonpsychopath	20		

Effects of Enhancing Realism in Laboratory Studies

Study	Group	N	% Accuracy Guilty	% Accuracy Innocent
Raskin & Hare (1978)	Psychopath	23	100	~92
	Nonpsychopath	20	100	~90

Effects of Enhancing Realism in Laboratory Studies

Study	Group	N	% Accuracy	
			Guilty	Innocent
Raskin & Hare (1978)	Psychopath	23	100	~92
	Nonpsychopath	20	100	~90
Patrick & Iacono (1989)	Psychopath	20		
	Nonpsychopath	21		

Effects of Enhancing Realism in Laboratory Studies

Study	Group	N	% Accuracy	
			Guilty	Innocent
Raskin & Hare (1978)	Psychopath	23	100	~92
	Nonpsychopath	20	100	~90
Patrick & Iacono (1989)	Psychopath	20	83	63
	Nonpsychopath	21	91	50

Problems with Field Studies

➤ How is ground truth established in real-life cases?

    ➤ Judicial verdicts inadequate

        ➤ plea bargains and false convictions

        ➤ evidence may 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 are gathered only after the subject has failed the test, which leads to an unfortunate selection bias

Why Using Confessions Overestimates Accuracy
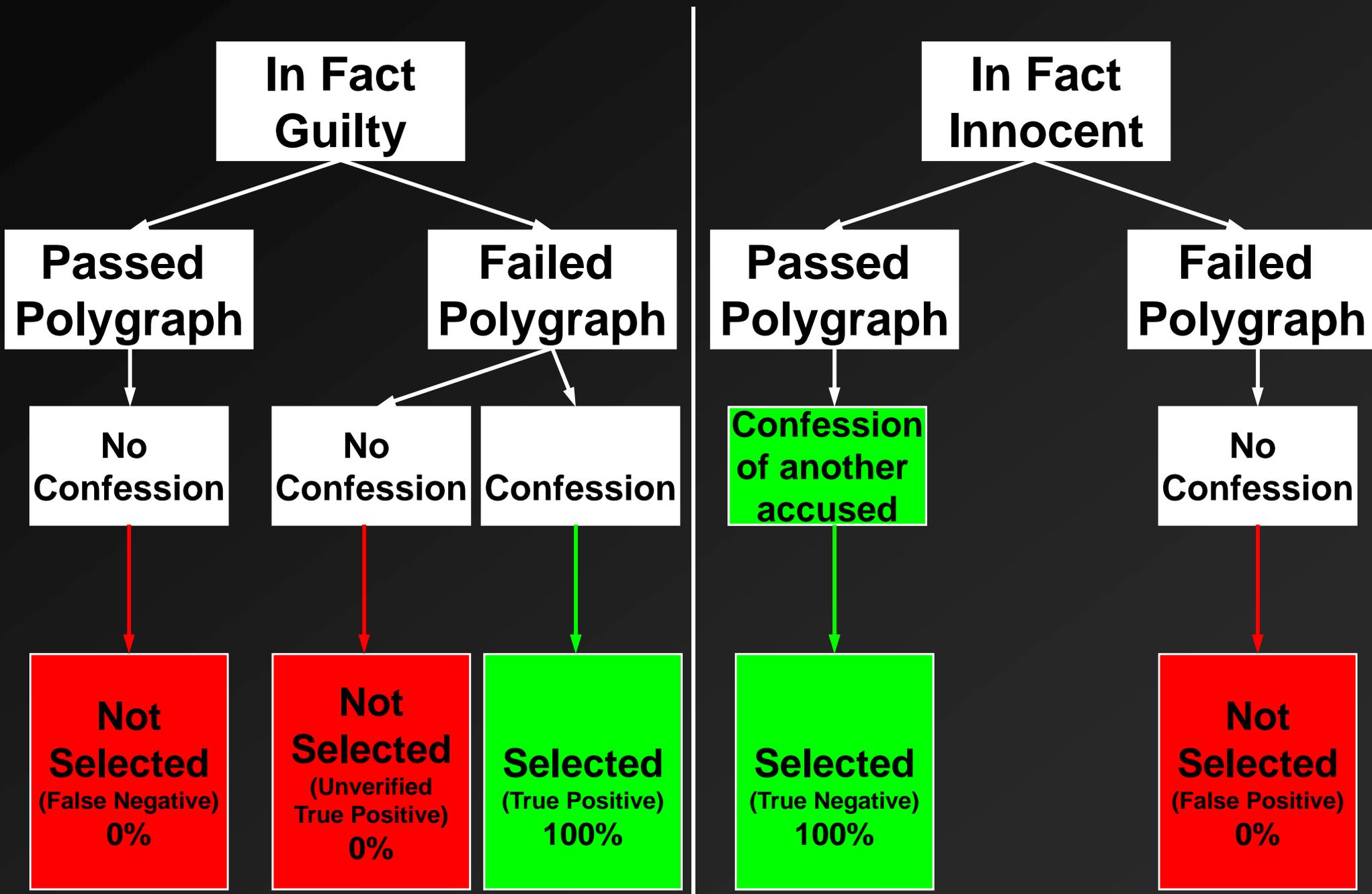
Screening Tests

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

	Test	Verdict	
Actual	Guilty	Not Guilty	
Guilty	9	1	10
Not Guilty	45	45	90
			100

❑Total correct verdicts = 54%

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)**
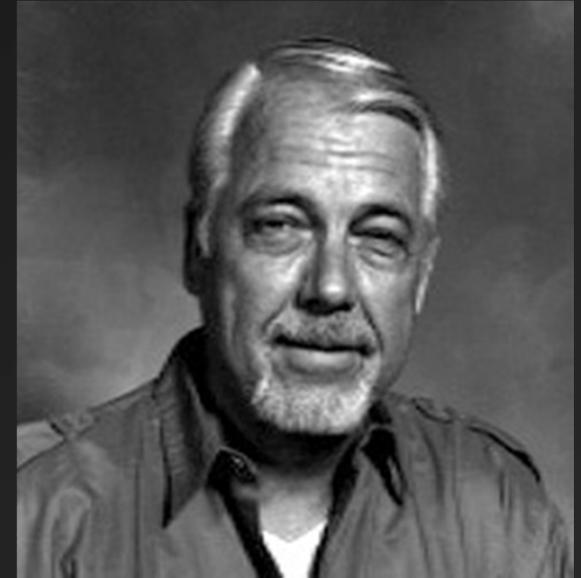
Guilty Knowledge Test (GKT)

➢ 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

Regarding the abduction location, do you know for sure it was…
1. … at a Toy Store?
2. … at a Shopping Mall?
3. … at a City Park?
4. … at a Friend's House?
5. … at School?
6. … at a Restaurant?

Other questions about
• Time abductee taken
• Clothing worn
• etc. for 6-10 questions

➢ 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

Study (1st Author, Yr)	N	Percent Correct	
		Guilty	Innocent
Lykken '59	98	88	100
Davidson '68	48	92	100
Podlesney '78	18	90	100
Balloun '79	34	61	88
Giesen '80	40	92	100
Bradley '81	192	59	89
Bradley '84	16	100	100
Iacono '84	55	91	100
Steller '87	87	85	100
Iacono '92	71	87	71
O'Toole '94	45	77	94
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

Countermeasures?

➢ **Drugs**

  ➢ **Waid, Orne, Cook, & Orne (1981), Meprobamate (a tranquilizing agent) and the GKT**

	Actual				Actual	
Verdict	Innocent	Guilty	|	Verdict/Drug	Innocent	Guilty
Innocent	11	2	|	Guilty-Placebo	3	8
Guilty	0	9	|	Guilty-Mepro	8	3

Questionable validity because study lacked realism and proper incentives

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%

Countermeasures?

➢ Street drugs and ETOH

    ➢Bradley and Ainsworth (1984) -- mild ETOH intoxication during mock crime decreased detectability during subsequent polygraph examination

    ➢Studies needed to determine effects of higher doses and of more potent drugs

        ➢To the extent that the drug interferes with memory or sense of responsibility at the time of the crime, it may serve as a potential countermeasure

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 if the GKT (Overall accuracy dropped from 85% to 25%)

Interim Synopsis

➢ People Lie

➢ There is no unequivocal lie response

➢ Traditional Polygraphy, which focuses on emotional reactions, suffers from an unacceptably high false positive rate

➢ Polygraphers overestimate the accuracy of the procedure 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

A TREMOR IN THE BLOOD
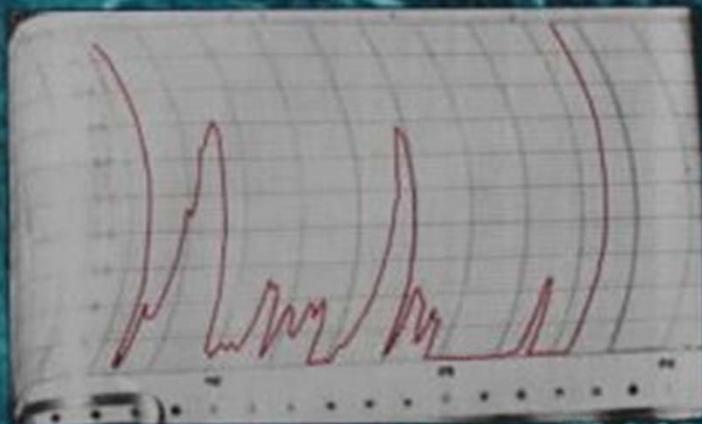
USES AND ABUSES OF THE LIE DETECTOR

DAVID T. LYKKEN

THE POLYGRAPH AND LIE DETECTION

COMMITTEE TO REVIEW THE SCIENTIFIC EVIDENCE ON THE POLYGRAPH

STEPHEN E. FIENBERG (*Chair*), Department of Statistics, Carnegie Mellon University

JAMES J. BLASCOVICH, Department of Psychology, University of California, Santa Barbara

*JOHN T. CACIOPPO, Department of Psychology, University of Chicago

RICHARD J. DAVIDSON, Department of Psychology, University of Wisconsin, Madison

PAUL EKMAN, Department of Psychology and Human Interaction Laboratory, University of California, San Francisco

DAVID L. FAIGMAN, Hastings College of Law, University of California, San Francisco

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